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For the American Railroad Journal and Mechanics' Magazine.

COST OF TRANSPORTATION ON RAILROADS. BY CHARLES ELLET, JR. CIV. ENG.

(Continued from page 382.)

I propose now to continue to produce those details of the cost of transportation on railroads, which enter into the approximate formula for the computation of the average annual charges, preparatory to the indication of certain modifications, which, in time, will be found necessary, in order to adapt the expression more strictly to the various cases which occur in practice. A reference to the table contained in a previous number of this Journal, (page 348) will show with what accuracy the formula, in its present state, applies to almost every variety of roads in the Union.

But it will occur to the experienced reader, that there are certain sections of the country on which the cost of fuel is exceedingly light; others where it is very great; that there are some lines provided with a double track; some on which the engines are unusually large, or on which the company are exposed to peculiar causes of expenditure. It will be readily conceded, therefore, that a formula *strictly* applicable to all these cases, ought to be expressed in more terms than the mere length of the line, the tonnage, the travel, and the miles run by the locomotive engines—which are all the quantities that appear in the rule which has been presented. But yet we have seen that that formula, as it is, does apply and give consistent results, and results quite close enough for almost any useful practical purpose, without any correction for these varying conditions. This circumstance, therefore, needs explanation; but before explanation can be advantageously offered, I must lay before the reader certain details which have been used in the construction of the formula. In anticipation of this explanation, however, I may observe that the true cause is, that these circumstances, which disturb the action of the general law, have very little influence compared with the value of the great items which compose the formula. I shall return to this subject again; but at present we may proceed with the determination of the values of the detail of expenses, and leave the slight corrections to be applied in conse-

quence of these irregularities—irregularities chiefly in the prices of labor and materials—for the sequel. The reports of the various companies for the current year, will shortly be published; and by introducing the results which it is to be presumed they will exhibit, under an improving system of economy, I hope to be able to make a still closer approximation to the truth. We shall have also, in a few weeks, the results of the year's operations on the Philadelphia and Reading railroad, from which we shall be able to verify experimentally, the influence on the cost attributable to a very large trade conducted under remarkably favorable circumstances.

I propose to consider next—

The Cost of Fuel.—It is obvious to every one that the *consumption* of fuel depends on the construction and power of the engine, the gradients of the road on which it operates, and the load which is conveyed. The *cost* of fuel really depends, in some measure, on these circumstances, but chiefly, in practice, on the *price* of wood; for in this country the price of a cord of wood is much more variable than any other element which affects the value of fuel, or the value of motive power.

The following table of the distance run by the locomotive engines in different parts of the country, together with the annual aggregate expense of fuel, and the reduced expense, per mile run, will serve to exemplify this point.

Table of the Expense of Fuel.

Name of Road.	Year.	Distance run by engines.	Expense of fuel.	Cost of fuel pr. mile.	Remarks.
		Miles.	*Dolls.*	*Cts.*	
Georgia road,	1842	152,873	6,405	4·2	South'n roads, average 5 cts.
Central road,	1842	102,145	4,810	4·7	
South Carolina road,	1842	260,324	13,950	5·3	
Portsmouth and Roanoke,	1842	96,000	4,700	4·9	
Petersburg road,	1842	131,160	8,200	6·2	
Baltimore and Ohio,	1843	509,765	33,447	6·6	Roads in middle States, average 9 cts.
Baltimore and Susquehanna,	1842	128,349	8,981	7·0	
Utica and Schenectady,	1841	155,828	11,000	7·1	
Philadelphia and Columbia,	1842	261,714	22,000	8·4	
New York and Erie,	1842	24,564	2,744	11·1	
Reading road,	1842	198,055	19,002	9·6	
Norwich and Worcester,	1842	144,321	14,662	10·2	New England Roads, average 13 cts.
Western road,	1842	397,295	50,774	12·8	
Providence road,	1842	120,000	17,548	14·6	

[Note.—The expense of fuel on the New York and Erie road includes the cost of sawing, and the loading of the tenders. The engines on this road, as well as a part of those on the Reading and Western roads, carry very heavy freight trains.]

On inspecting this table we observe that the cost of fuel for each mile travelled by the engines, increases very uniformly as we proceed from south to north. We know, also, that the price of wood likewise increases on the route, though not precisely in the same proportion. Wood is worth, on the

average, two and a half times as much in New England as it is in Georgia—but there are roads in New England on which the expenditure for fuel is from three to four times as much as it is on some of those of Georgia. This difference is not wholly attributable to variations in price, but depends, in part, on the size of the engines, and the magnitude of the trains conveyed. The engines on the southern roads, are, in general, not quite so heavy, nor so heavily loaded, as those used on several of the northern lines—a circumstance which somewhat, though not very materially, influences the result. Waiving the influence of this consideration, and regarding the engines as of nearly the same average weight on all these lines, this table will supply us at once with a correction to the formula, which we may apply when we desire to approximate more closely to the actual expenses.

The formula, for computing the aggregate annual expenses of a railroad, is based on an average cost of fuel of 9 cents per mile run.

In making the application, from year to year, we shall find that the results which it supplies will need to be modified, and that this modification will be equal to an addition of 4 cents per mile run for the New England roads, and a reduction of 4 cents per mile run for the Southern roads.

Wages of Train Hands.—It is the practice of many companies to include the wages of enginemen, firemen, conductors, breakmen, etc., in the item of fuel and salaries; of others to combine them with oil and repairs of engines and cars. Indeed, the heterogeneous mixture of items, which are presented to the public in a lump, cannot but lead sometimes to the conclusion that it is the object of the report to conceal the naked truth. It cannot be supposed that any company mingle such dissimilar items together in their own books; and as it is really easier to copy off the items under their separate heads, than to add them together and present them in a mass, it must be supposed that the object of the condensation of matter is to prevent an intimate acquaintance with their affairs. This inference is strengthened, in my estimation, by the fact that the accounts of those companies which pursue this course, exhibit an annual, and sometimes vast, augmentation of capital. By keeping the items concealed, the public are forbidden from ascertaining what portion of the ordinary current charges go to swell the annual charge to construction, and the deception is thereby practised longer with impunity. There are certainly some remarkable exceptions which might be named as good models for imitation. The accounts of the Georgia road are always presented with clearness and accuracy; and though they might be greatly improved by the addition of the net and gross tonnage, and travel conveyed one mile, they exhibit, in their present state, a much better appreciation of the importance of knowing the precise and detailed condition of their business, than is observable in the statements of other similar institutions.

The report of the Baltimore and Ohio company, for the current year, also stands out conspicuous amidst the general confusion; and as ought to be

expected, *every item* of expenditure on that line compares advantageously with the same item on any other road in the country.

The directors of the Norwich and Worcester road in New England, have published a table which might be made valuable, but it is actually rendered almost useless for want of the amount of the business transacted. The number of tons of goods, and the number of passengers conveyed one mile, ought to have been stated, and the different classes of wages should have been separately given.[1] It is of little use to tell us the exact amount of expenses incurred in the transportation of freight without informing us of the amount of freight transported.

The directors of the Western road have also presented much valuable detail; but they have failed to exhibit the item of "services" under appropriate heads. No correct judgement can be formed of the economy of the administration of a line on which the salaries of agents and superintendants, president and engineer, train-hands and wood-cutters, clerks and ticket-men, are condensed into one total. The separation of this column—the accurate addition of the number of passengers carried one mile, and the *quantities* of each sort of fuel consumed—would render the report of this company a most valuable document. I trust that they will not be detered from continuing this detailed exhibition of their affairs, when their road and machinery begin to manifest some of the effects of time and use.

In conesquence of this mingling of items, I am unable to separate, with the desirable precision, the sum paid on many roads for wages to the engine hands, from that paid to the conductors and brakemen. For this reason I find it convenient to include the wages of all the train hands in the item of locomotive power. This item must, accordingly, be expected to vary with the magnitude of the train, and, somewhat, with the acclivities of the gradients: heavier gradients and the larger trains requiring usually a greater number of breakmen.

The variations consequent on this cause, are, however, very small; and we will come exceedingly near the truth by this formula,

$$7\tfrac{1}{2}+\frac{t}{25}$$

for the value of the wages to the train hands, in cents, for each mile travelled by the train—t standing for the average number of tons of freight in each train. The correctness of this approximation will be seen by a glance at the following table.

TABLE.

Name of Road.	Year.	Miles run.	Wages to train hands.	Wages per mile.	Remarks.
			Dolls.	*Cts.*	
Reading road,	1841	83,717	5,785	7·0	With moderate trains.
Reading road,	1842	198,055	17,752	9·0	With heavier trains.
Boston and Providence,	1842	132,229	10,799	8·0	Medium trains.
Baltimore and Ohio,	1843	509,765	31,161	6·1	Light trains and heavy grades.
Eastern road,	1842	184,127	14,774	8·0	Trains on both these roads are moderate.
Georgia road,	1842	152,873	12,666	8·3	
Petersburgh road,	1841	131,160	14,558	11·0	The Petersburg road was worked at disadvantage in 1840 and 1841. The freight trains on the New York and Erie road are unusually large.
New York and Erie,	1842	24,564	2,814	11·5	

The average value of wages, excepting for roads on which the trains are excessively large, may be safely and justly assumed at 8 *cents per mile run.*

Oil and Tallow for Engines.—The expense of oil is certainly a very small matter, when compared with the aggregate yearly charges against a railroad company; but it is a very important matter for every company to know exactly what this, and every other item of expense really is, and ought to be, in order to judge of the possible ameliorations of their management. On the Georgia road, in 1840, the mere greasing of the engines amounted to more than 4 per cent. of the aggregate charges of the company. In 1842, this item was reduced down to less than 1½ per cent.

As another example of the effect of the same sort of economy in the detail—in small matters—may be adduced the curious fact, that the sum paid for oil by the Philadelphia and Baltimore railroad company, in 1841, amounted to $6,131, and in 1842 it was reduced down to $2,151. In the year 1841 it amounted to 3⅛ cents per mile run, and in 1842 it scarcely exceeded 1⅛ cents per mile run by the trains.

The expense of oil is generally included under the head, "fuel, oil, salaries, general and incidental expenses, etc.;" "fuel, oil, salaries, wages, loading merchandize, and miscellaneous expenses;" "wages, fuel, oil, etc." This method of condensing accounts is so general, that out of the reports of more than thirty railroad companies for the year 1843, now on my table, I am able to select but the three following, from which the cost of oil, consumed by the engines, can be obtained separate from other items.

TABLE.

Name of Road.	Year.	Miles run by engines.	Cost of oil for engines.	Cost per mile run.	Remarks.
			Dolls.	*Cts.*	
Georgia road,	1842	153,873	1,411	·9	Cotton waste is included in the charge on the Baltimore and Ohio, and believed to be included in that of the Georgia road.
Baltimore and Ohio,	1843	509,765	4,399	·9	
Philad. and Columbia,	1842	261,744	3,104	1·2	Including oil for stationary engines.

This table would seem to justify the assumption of 9 *mills per mile run*, for the consumption of oil and cotton waste by the engine and tender alone.

There is to be found a considerable list of reports in which the aggregate consumption of oil by engines, tenders, and cars, may be separated from all other items. I have also some manuscript statements from which these items can be obtained. The following table exhibits the aggregate cost of oil for various lines, and the cost reduced to the mile travelled by the train.

TABLE.

Name of Road.	Year.	Miles run by trains.	C'st of oil for eng's & trains.	Cost per mile run.	Remarks.
			Dolls.	*Cts.*	
Central road,	1842	102,145	1,103	1·0	Light trains,
Reading road,	1841	83,717	1,621	1·9	Heavier trains,
Reading road,	1842	198,055	3,936	2·0	Still larger aver. trains,
South Carolina road,	1842	260,324	2,784	1·1	
Utica and Schenectady	1841	155,828	3,500	2·2	Not strictly accurate,
Philad. and Baltimore	1842	177,859	2,151	1·2	Chiefly passe'g'r trains,
Georgia road,	1842	153,873	1,821	1·2	Trains equal preced'g,
Norwich and Worces.,	1842	144,321	1,947	1·4	Wei't of trains unkn'n,
Western road,	1842	397,295	9,215	2·3	Heavy trains,
New York and Erie,	1842	24,564	481	2·0	Heavy freight trains,
Baltimore and Ohio,	1843	509,765	7,201	1·4	Lighter trains.

The consumption of oil and tallow may be estimated, in general, at 9 mills per mile run for the engine and tender, and an additional allowance of ¼ mill for each ton net conveyed one mile.

I have also the consumption of oil and tallow for some other lines, but as these statements manifest great and censurable extravagance, and cannot be used to show the necessary expenditure on a well conducted road, I have not included them in the preceding list.

Sawing Wood, Pumping Water, and Loading Tenders.—It is not easy to collect facts which will exhibit the actual cost of the items included under the present head for many roads; but it is very easy to estimate their average value by direct calculation. We know that it is worth, on the average, about 40 cents per cord to saw the wood suitably for this purpose: and we know also that a cord of wood is sufficient to supply the consumption of the engine while running about 40 miles. It is, therefore, worth *one cent per mile run*, to cut the wood for this purpose. To load the tenders, where the business is regular and great, is worth about 20 cents per cord, or *a half cent per mile run.* The cost of raising the water depends more on the conveniences afforded by the situation. If we assume the average lift at 30 feet, the labor of a man will be equal to raising about 40,000 pounds per diem. Engines usually consume from 300 to 400 pounds of water per mile run, which brings the cost of pumping to about the $\frac{1}{110}$ of a day's labor—or about 8 mills *per mile run.* These items make together 2¼ cents per mile run.

The result of experience for two roads is given in the following

TABLE.				
Name of Road.	Year.	Miles run by engines.	Cost of sawing loading and pumping.	Cost per mile.
Boston and Providence,	1842	120,000	$3,266	2·7
Philadelphia and Columbia,	1842	261,774	5,989	2·3
			Average,	2½ cts.

Locomotive Power.—We have now gone over the items in detail which compose the cost of locomotive power, and are, therefore, prepared to sum them up, and compare the aggregate of the averages with the amount at which it is stated in the formula, proposed for the computation of the aggregate annual expenses. These items are

	Cents.
Repairs of engines and tenders per mile run, - - -	7·0
Fuel per mile run, - - - - - - - - -	9·0
Wages of train hands per mile run, - - - - -	8·0
Oil for engines and tenders, per mile run, - - - -	0·9
Sawing wood, loading tenders, and pumping water, per mile run,	2·5
Cost of locomotive power per mile run, - - - -	27·4

It will, of course, be recollected that this result is independent of the injury to the road, which we have considered under the usual head of "extraordinary expenses."

The only division of these expenses which is liable to material variation, is the cost of fuel, the price of which varies with the localities. I have already offered an approximate correction of this item, which may be employed for general investigations; and shall shortly take occasion to present a more accurate formula for its computation, based upon a very extensive experience.

It might seem to the general reader, that after presenting the cost of repairs of the road, engines and cars; the value of fuel and wages of train hands; the consumption of oil, and the injury to the iron, that there would remain but little more to adduce in the premises; but I have yet a very important division of the subject to discuss, which is much too frequently overlooked in investigations of this character.

There are other extraordinary expenses, and certain contingencies which go far to swell the annual charges on every line—without any exception in behalf of the most favorably situated, or of those which are most economically administered.

I proposed, in a former article, to offer an estimate of the probable expenses on a railroad in active operation for the present year, which is now the object of much attention and interest, in order to exhibit an application of the formula in anticipation of the publication of the company's next report. I take the Philadelphia and Reading railroad for this purpose; and assume that it will this year give transit to 250,000 tons of freight, and 40,000 passengers. The application of the formula to this work—making proper allowances for its gradients and drawbacks, and facilities for unloading, and hav-

ing due respect to its age—will produce for the aggregate expenses, the sum of $265,000.

This estimate, of course, refers only to the apparent expenses, and includes no part of those reserved charges—such as the wear of iron—which are usually denominated "extraordinary expenses" because they are not generally of annual recurrence. The durability of iron rails I assume at about 800,000 tons—while they are estimated by the enthusiastic friends of the Reading railroad, at 12,500,000 tons. Where such immense differences exist, time must decide the question. I trust that time may not show that I, even, am too sanguine and expect more from the railroad system than it is capable of rendering.

(To be continued.)

NOTES ON PRACTICAL ENGINEERING.—NO. 4.

Bridges.

In looking back at the different kinds of bridges which have been built during the last ten or twelve years, it is obvious that there is a fashion which rages for a certain time when some particular bridge is generally adopted for new structures, but which soon falls out of use and is succeeded by another temporary occupant of public favor.

Lattice bridges were much in vogue some eight or ten years since and were very extensively introduced on railways. Where the span does not exceed 100 feet and where the roadway can be carried on the top of the framing so as to admit of vertical transverse bracing, this plan does very well. There is, in Weale's bridges, an engraving of one of these structures similar to the bridge over the Hudson at Troy, built with double lattice and for a double track with suspending posts in the middle. The span at Troy is 180 feet and the bridge is by no means stiff. The same remark may be applied to a similar bridge of about the same span on the Harlem railway. These bridges require very good horizontal bracing to keep them in shape, they must be weather boarded, they require a large quantity of timber and they burn with a rapidity almost incredible. Thes disadvantages have been the means of banishing them from railways in this country though an English engineer introduced them on a railway in England only a few years since.

A very ingenious modification of this bridge was devised by Mr. Haupt, of Philadelphia and an account of it with a sketch of the bridge was published in this Journal.

Col. Long's bridge is very well known throughout the Union. It is a good specimen of carpentry, is very stiff, does well without boarding in, but after a few years the pressure of the braces splits off the shoulders of the posts against which they abut, that is if the posts nearest the abutment, the pressure of course diminishing towards the centre of the span.

In order to obviate this difficulty, Messrs. Hazard & Co., contractors, introduced a set of braces radiating from the abutment to the head of each post, or rather pair of posts, and occupying the space allotted to the counter

brace in Long's bridge. Numerous structures of this kind have been put up and are well spoken of.

Another contractor, Mr. Howe, designed and erected the railway bridge over the Connecticut at Springfield in which iron rods supply the places of the posts; the braces, which are of timber, cross each other in the style of lattice work. There are, however, two braces and one counter brace, the vertical rods passing on either side of the latter. There is perhaps less work on this bridge than on any other, and the braces and rods may be very easily replaced. It is not screwed in. The wood work of this bridge is a sort of compound of the bridges of Town (lattice) and Col. Long.

The architectural effect of these different bridges is what might be expected from an enormous square box and, whether boarded in or not, may be safely put down as a minimum. They all avoid the arch, which adds so much to the strength of Burr's bridge, a structure which the writer has generally found deficient in stiffness, though it is proper to say that his acquaintance with it is less extensive than with others. Although generally roofed and boarded in, the arches take off something of the dull rigid outline by running beneath the floor at the haunches. Where, however, floods approach the floor of the bridge, this springing of the arches lower down on the abutment is obviously attended with inconvenience and even danger in some cases.

In short spans it will be generally admitted that the old plan with two queen posts and good iron straps is the cheapest and at least as good as any other. For common road bridges, this mode of construction has been used in spans of considerable length and is applicable to railway bridges at least as far as 50 feet. It is a good plan to carry iron rods from the ends of the braces and straining beam near the head of the queen post down through the strings, instead of merely passing them through the strings or tie beam and bolting them to the lower end of the queen posts.

Indeed too little iron has been used in many American bridges, and although Dr. Robison says, "a skilful carpenter never employs many straps, considering them as auxiliaries foreign to his art," the experience of this country in lattice bridges, Long's bridges and others where reliance has been placed on the lateral cohesion of the fibres in the shoulders of the posts in Long's and Burr's plans, and on the close fit of the pins in lattice bridges, would appear to indicate the propriety of introducing a greater quantity of iron as well as bestowing greater attention on the dimensions and minor details—as heads, washers, threads—than has been done in many instances.

In looking at the various parts of an English wooden bridge, an experienced eye sees at a glance that no labor has been spared on details; that the minutiæ have deen carefully weighed even in designing a bridge 5 or 6 feet wide to enable the horses to cross a canal. Although their comparative durability cannot well be known, it must be admitted, that with the same quantity of material and but little if any more labor in the constructiou, they present an appearance of neatness, finish and adaptation to the object aimed at,

which will be found in very few American wooden bridges. It would, however be unfair to the American engineer to stop here. It is unfortunately the custom here to give a preference—in the case of road bridges—to some builder or contractor, often a patentee of some plan infinitely more ingenious than judicious, over the educated and experienced engineer, whose promises, before the commencement of a work, fall as far short of those of his rivals as his actual performances exceed the crude and almost invariably more costly productions of these people.

Now the English bridges with which we become familiar through the various publications of the day, are all or nearly all designed by members of the profession or persons well qualified by education, experience and character, and the result is precisely what might be expected. In the case of stone arches on some American railways, the design and execution of the work would confer credit on any engineer in any country, but such opportunities are of rare occurrence. This very circumstance shows what might be expected from the profession in this country were arches of stone more generally adopted, and the excellence, abundance, and almost infinite variety of the material must at some future day cause many of the smaller streams to be adorned with these unrivalled structures. Many wooden bridges on railways are brought down by the grade of the line as near as possible to high water mark, hence there is comparatively little opportunity for architectural effect in such cases. With road bridges this is not generelly the case, and a rise of a few feet in the centre of the span is no objection. There is a very good specimen of a road bridge in the Civil Engineer and Architect's Journal, vol. I, p. 177, and all must recollect the elegant and graceful "Pont du Carousel" by M. Polenceau, constructed of cast iron and timber, a combination which may be introduced in an endless variety of ways and proportions, and which the great improvement in the quality and the gradual reduction in the price of American castings renders well worthy of our attention.

New York, Dec., 1843. W. R. C.

For the American Railroad Journal and Mechanics' Magazine.

I have read with some surprise a series of articles which have appeared in the Journal on the "Cost of transportation on railroads, by C. Ellet, Jr. C. E." Had the statement been perfectly correct and Mr. E. had succeeded, as I do not doubt he has, in producing a formula which will come within 12 per cent of the expenses from the known business on any particular road, I am still to learn to what use it can be applied. My object, however, at present, is not to discuss the formula but to correct some gross mis-statements which have appeared in the last two articles, in relation to the South Carolina railroad, and then leave your readers to judge how much confidence is to be placed in what he says of the other roads. If what he advances in relation to the cost of renewing the iron on railroads be true, railroad companies cannot too soon get rid of such unprofitable property.

In his comparative statement of the actual and calculated expenses of the South Carolina railroad for 1842, the through tonnage is put down at 27,-

000, and through passengers at 24,000. The income from freight during that year was $192,823, which divided by $8, about the charge for transporting a ton over the road, gives 24,000; and the receipts from passengers for the same time were $127,684, and this divided by $8, the charge for a through passenger, gives for the total through passengers 16,000. The expenses calculated by the formula for 24,000 tons and 16,000 passengers, will be $200,500, in place of $214,000, or an error of 12 per cent. in place of 5 per cent. In the same statement, the expenses of the Western road are quoted at $256,619, in place of $266,619, as stated in the company's report, or an error of 4 in place of 0.

To the statement of the cost of repairs of engines on the Georgia railroad, Mr. E. appends this note—"This company have added to the usual division of their expenses into ordinary and extraordinay repairs, the new classification of 'improvements to engines;'" not being able to conceive that a small stock of engines could run 153,000 miles and be materially improved by it, I regard these "improvements" as expenses. I cannot conceive how any stock of engines could be improved by running 153,000 miles; neither do the Georgia railroad company say that theirs were, but they do say that two of their engines were improved by expending $950, in substituting "small driving wheels and large cylinders" for "large driving wheels and small cylinders;" and that these and other improvements have enabled them to dispose of one of their "small stock" of 12 engines. Moreover, the company have charged these improvements to "cost of repairs of engines," and have not, as they might have done, credited the "cost of repairs," with the proceeds of the engine which these improvements enabled them to part with.

Mr. Ellet says, "the first iron used on the South Carolina road was destroyed in less than six years—after it had borne about 130,000 through tons and 120,000 through passengers, and the locomotives had made 10,000 through trips." The iron was *destroyed* in less than six years! The company in their report of November, 1833, state that the iron delivered on the road cost $109,453 80; in their report of July, 1841, and in all their subsequent semi-annual reports, there is credited to cost of construction "*old iron sold* $92,321 75," the sum which was received for 1,800 or 2,000 tons, three-forths of the original weight. From this it will require no prophet to inform Mr. Ellet that the iron which originally cost the company delivered on the road, $40 per ton, was sold by them for nearly $50! after it had been "destroyed in less than six years." Of the remainder of the iron, a large portion still remains in the depot tracks and turn outs on 136 miles of road, little short, I should suppose, of 10 miles; much has been used in the work shop in the construction and repairs of locomotives and cars, and many other purposes; and lastly, some of it was loaned to the contractors for earth work on the Louisville, Cincinnati and Charleston railroad, and bore a transportation of 40,000 or 50,000 cubic yards of sand and hard pan, equivalent to eighty thousand tons besides the cars, (as some of the contractors, much to their sorrow, can testify,) or more than one-half the tonnage which was

sufficient to destroy it, and this, mind you, after it had already been destroyed, and what is quite as wonderful, the company were foolish enough to receive it back again without making any charge for the use of it, considering that it had not been materially injured. Here, at least, is *one* iron rail that could not be considered "bad." From what I have here stated, I think it will not be a very unfair conclusion to draw, that the iron which "was destroyed in less than six years," afterwards brought the company in cash, and in other shapes, as much as it originally cost them delivered on the road; and that in this case,

$$a \text{ N}+b \text{ T}+c \text{ P}=0.$$

This may be no exception to the rule, but like the engines on the Worcester road, is certainly a case in which the formula does not apply. Trusting that your correspondents will furnish you with sufficient authentic data to come within $1,000 of the value of the above expression, I will conclude these remarks with the following quere. Recollecting that "*the destruction of the* T *or* H *rail will be greater*" than that of the plate rail, in other words, the heavier the rail the faster it wears, if a plate rail weighing 12 or 13 lbs. per yard can bear the transportation of 80,000 tons after it has been *destroyed*, without being materially injured by it, how much can be transported over a rail weighing 60 lbs. per yard, (like that on the Reading road) without rendering it unfit for use? Q.

BALTIMORE AND OHIO RAILROAD REPORT FOR 1842.

For this report, as for many other favors, we are indebted to Mr. B. H. Latrobe, the chief engineer, who will please accept our thanks.

From this report we learn the following facts, viz:

1st. That on the main stem the rates were reduced on passengers 25 per cent., and on tonnage 30 per cent; and that the number of passengers has more than doubled, and the tonnage nearly doubled; while on the Washington road the number of passengers has fallen off 17 per cent, and the tonnage 8, where the rates were *not* reduced, notwithstanding the roads south of Washington materially reduced their rates, and thus gave this road the benefit.

2nd. That the *cost* of transportation has been reduced on the main stem, on feight, *fifteen* per cent., and on passengers *fifty-six* per cent.; while on the Washington road the cost of working the road, during the past year, with a *reduced* business, is only $46 less than the previous year.

3d. That the excess of nett revenue, on the main stem, this year over the past, is on passengers $93,440, and on freight, $55,401; while the nett revenue on the Washington road is less than last year. It is to be borne in mind, however, that the extension of the main stem to Cumberland has mainly, or largely, contributed to this increase.

The report shows an encouraging state of affairs, and calls loudly on the citizens of Baltimore and of Maryland to push forward this important work, and we hope to learn soon that efficient measures have been adopted for extending the road to the Ohio river.

We have watched, with deep interest, for nearly fifteen years, the progress of this work; and it is nearly twelve years since the reports of the company were published in this Journal, and although exceedingly anxious to examine the work, yet, not until the past summer was the writer able to visit and pass over it, though frequently invited so to do. In June last, while on a short visit to the monumental city, we availed ourself of a polite invitation from the chief engineer to accompany him over the road to Cumberland, which afforded us an opportunity to form a better idea of the labors performed by this pioneer company. It has truly been a herculean work, especially when we consider the difficulties to be surmounted, and the limited experience in relation to the construction and working of railways when it was commenced. But the main difficulties are overcome, and the vast importance to Baltimore of its speedy completion are becoming daily more evident and of course renewed efforts will be made this winter to provide the means for prosecuting the work vigorously next season; and it is to be hoped that the citizens of Baltimore, who have done so much in the cause of railroads, may, at an early day, derive all the benefits which they have anticipated from this noble work.

With the facts contained in this report before them, it is to be hoped that the legislature of Maryland will adopt measures authorizing the company to reduce the fare on the Washington road, in accordance with the spirit of the times, and thus increase the profits next year. Of *one* result they may rest assured, and that is, that if they do not reduce their rates, the *travelling community* will avoid this road, when they can do so, and *thus* reduce their income. It is a fact now well established, that in *most* cases, where the rates have been reduced, the travel has so increased as to augment the *nett revenue*; and it will be so on this road, we have not a doubt, as it would be between New York and Philadelphia by a reduction of the fare to $3, or even to $2 50—which we hope may soon be done.

At a meeting of the stockholders held pursuant to the charter, on the second Monday of October, 1843, in the city of Baltimore, the president and directors of the Baltimore and Ohio railroad company submitted the following report and statement of the affairs of the company:

In the last annual report it was stated that the road would be completed to Cumberland between the first and tenth of November, 1842. It was accordingly opened on the fifth of the month, and has ever since been in operation from that point; thus accomplishing another, and by far the most important step towards the extension of this great work to its final destination.

The new part of the road west of Harper's Ferry may be said thus far to have answered the expectations of the board; and, independently of the necessary expense of keying up the bridges, requiring an inconsiderable expenditure in the adjustment of its parts.

During the past season, however, many parts of the country between Harper's Ferry and Cumberland have been visited with several freshets of unexampled power; the water suddenly rising on two occasions some feet higher than was ever before observed; and either sweeping away or materially injuring various works and descriptions of property throughout the country, which had successfully withstood all previous floods.

At three points within three miles of Harper's Ferry, one of the freshets did considerable damage to the railroad, by carrying away three of the culverts and portions of the embankment. At one of the culverts near the Little Cacapon, some slight damage was also sustained. The injuries, however, were temporarily repaired with such despatch as that the travel was interrupted over those parts of the road for a few hours only, and the transportation of burthen for not more than three days.

To repair permanently the damage, and to place the culverts beyond the reach of even a higher rise in the water, may be expected to increase the expense of repairs in the current year about $15,000, being upwards of $2,000 less than the surplus on hand from the year just ended.

All the other part of the road withstood without injury the force of these unexampled floods; and their strength may be considered sufficiently tested to inspire new confidence in their future stability.

In consequence of the opening of the road to Cumberland, and upon the commencement of the spring trade and travel, the charges for transportation, both of passengers and merchandize, upon the Pennsylvania lines were considerably reduced, and throughout the year have been kept at rates which it is believed are not required by the public nor justified by the true interests of the works. Nevertheless, to meet such competition, and to enjoy any share of the trade, it became necessary that the board should reduce the charges upon the Baltimore and Ohio railroad; and they were accordingly reduced, for passengers about 25 per cent., and for tonnage about 30 per cent. below the rates of the previous year. For some time after the opening of the road to Cumberland, the difficulties of wagon transportation over the National road, both as to capacity and rate of charge, also interposed serious obstacles to the trade upon the railroad; and these it will not be possible wholly to surmount until the road can be extended to the Ohio river.

Notwithstanding these impediments, the operations of the road between Baltimore and Cumberland since the 5th of November, 1842, have been altogether encouraging, fully warranting the expectations which urged its completion to that point; and calculated to inspire the stockholders and the board with renewed zeal in their future exertions to carry it onward.

The statement B exhibits the revenue and expenses of the main stem during the year ending on the 30th of September.

It is deemed proper also on the present occasion to submit a tabular statement, prepared by the engineer of machinery and repairs, exhibiting in detail the operations and various actual expenses incident to the working of the main stem during the year, together with the amount of receipts from all sources during the same period.

These statements exhibit a gratifying augmentation in the trade and travel upon the road; and as proportioned to the work done, a continued reduction in the cost and expenses of transportation.

The excess of revenue for the past over the preceding year, for passengers, is $93,440, and for tonnage, $55,401, amounting together to $148,841.

The nett earnings of the main stem, independent of the Washington road, over and above the expenses of working the road, amount to the sum of $279,401 55, being equal to 4 per cent. upon the capital.

The railway east of Harper's Ferry has been considerably improved, both in adjustment and material during the year; and that west of the same point, with the exception of the injuries already mentioned, is in better adjustment than at any time since it was opened.

During the year, one new engine has been added to the moving power, and another will soon be placed upon the road. The entire complement

will then consist of twenty-eight locomotives; and the present business of the road will require, upon the average, at least twenty-two to be in actual daily operation. It is not doubted that in the present state of efficiency, the moving power will be adequate so an increase of at least fifteen per cent upon the business of the past year.

The passenger and burthen cars, and the depots and water stations are in good condition. There are also on hand duplicate parts of machinery, and a stock of materials for general repairs, and for the construction of burthen cars, exceeding those of any previous year; amounting in the aggregate to more than $40,000. As a general result from these statements, and the operations of the year, it may be stated that during the past, as compared with the preceeding year, the number of passengers transported one mile has been more than doubled, and the amount of tonnage nearly so; that the cost of transportation of passengers has been fifty-six per cent., and of transportation of tonnage fifteen per cent. less than in any previous year; and that if consistent with the competition with other works the board could have maintained the original rates of charge, with the same economical cost, an equal amount of business would have yielded a nett revenue of little less than seven per cent. upon the capital employed.

The board having reason to believe that their present power might be beneficially employed in the transportation of coal from Cumberland to dam No. 6 on the Chesapeake and Ohio canal, to be carried thence by the canal to the District of Columbia, have consented, upon the application of the canal company and others, at present to fix the charge upon coal between those points, at two cents per ton per mile; and will be ready as soon as the canal may be navigable, to engage in the transportation of that article upon these terms. The present rate is of course fixed with reference not only to the quantity offered for transportation, but to the permanence of the trade.

With a satisfactory assurance that the business would be permanent, the company might engage in it at a less charge than two cents per ton per mile, on any part, or for the whole extent of the road. The board, however, would not be justified in the expenditure of a large sum to augment the moving power and provide machinery not adapted to other purposes, if upon the completion of their preparations, they might encounter competitors even at no lower rate of charge.

All debts due from the company, and not in dispute, during the past year, including $50,000 of principal and 23,355 of interest to the Messrs Baring, under the arrangement for the iron rails communicated to the stockholders in the last annual report, have been discharged; and those remaining unpaid do not in all exceed the sum of 40,700 dollars.

The nett revenue of the main stem (including the sum of $46,467 received from the Washington road) after payment of the foregoing debts, amounts to 172,479; of which the board have determined to appropriate $15,000, according to the pledge in the last annual report, as the commencement of a sinking fund on account of the loan of $1,000,000, for the Washington road.

Of the ballance they have determined to divide among the stockholders $2 upon each share of stock, payable on and after the 1st day of November next, reserving a surplus of 17,479.

Before passing from the accounts of the main stem, the board deem it proper to remind the stockholders that in the operations of the past year, they have not only encountered the competition and impediments already adverted to, but have been exposed to the heavy charge incident to the employment of horse power in the introduction of passengers, as well as burthen, into

the city. The amount of such charge, with the present travel, may be estimated at from 12,000 to $15,000 annually. It must of course increase in proportion to the augmentation in the number of passengers, unless the present system be abandoned, or the city authorities should think proper to permit the introduction of the locomotives; as is now permitted in some other cities, and partially in Baltimore, without injury or inconvenience.

The nett earnings of the Washington road for the year ending on the 30th September, 1842, authorised a dividend of five dollars per share, and left a surplus of 8,834 40.

The nett earnings for the year ending on the 30th ultimo, are 61,691 46, which added to the surplus of the preceding year amount to $80,525 86, of which the board have decided to divide among the stockholders four dollars and fifty cents per share, payable on and after the 1st day of November next, retaining a surplus of 6,275 86.

From this it will be seen that during the past year the company have paid on account of the subscription to the Washington road $13,533 more than they have received from its earnings.

The sum paid to the State for the six months from the 1st of January to the 1st of July, 1842, being one-fifth of the gross receipts from passengers amounted to 20,500 26, and from the 1st of July, 1842, to the 1st of January, 1843, to 18,125 69, together $38,625 95. The amount paid to the State on the same account for the half year from January to July, 1843, was 15,439 88 dollars.

It is also to be remarked that if the sum of 33,565 57, paid to the State on the 1st of January and 1st of July, 1843, the one-fifth of receipts from passengers, there be added the sum of 24,750, the dividend of the Washington road, 10,000 from the main stem, and 1,269 60 regularly remitted by the board to London as the interest upon $5,250 sold of the subscription of $3,000,000, it will appear that the State has received during the year the sum of $69,585 17, being nearly seven per cent. upon her entire actual investment in both roads.

The railway, the passenger and burthen cars, and depots and water stations of this road are in good condition; and the expenses of repairs, and cost of transportation in the aggregate vary in a small degree from those of the preceding year. The aggregate value of materials on hand for repairs of railway, locomotives and cars may be estimated at 5,900 dollars.

A comparative statement of the operations upon the Washington road during the past and preceding year, is appended to this report.

It shows that, although the cost of working the road in both years has been nearly the same, the falling off in passengers has been at least 17 per cent., and in tonnage about 8 per cent.; and, consequently, that the diminution in the revenue is mainly, if not wholly, attributable to a decrease in the passenger travel. Such result was apprehended last autumn as likely to arise from the cheaper competition by the bay line of boats from Baltimore to Norfolk; and a application was made to the legislature, at the last session, by parties concerned with the southern portions of the inland route, to authorize a reduction of the charge for passengers on the Washington road. The application proved successful; and although this board thought the apprehension well founded, and concurred in the justice and propriety of co-operating with the southern companies in a fair reduction throughout the line, they had no power to alter the rate of charge for passengers between the two cities, or to bear any proportion of a reduction by others, without the authority of the legislature, or, in the recess, of the Governor of the State.

The charter also makes it lawful for the legislature, upon the application by the railroad company for any reduction in the established rate, so to regulate the charge as without reducing the proportion of one-fifth at present reserved to the State, in fact increase it, and reduce only the share of the company.

Unwilling to expose the interests of the stockholders to the operation of this provision, the board declined preferring any direct application. They, however, caused a communication to be made to the Governor on the 2nd of August acquainting him with the actual falling off of the business of the road, subsequent to the adjournment of the legislature, and calling his attention to the causes which it was supposed had contributed to it. To this letter an answer was transmitted by the secretary of State on the 5th of September, acquainting the board that, in the opinion of the Governor, the charter authorized him to consent to a reduction of charges for temporary objects only, without power to provide for the case to which the company had called his attention; and that, besides, he did not feel justified in interfering in the present instance, inasmuch as the legislature at its last session, had the whole subject under consideration and did not think proper to act.

It is proper to add that without the co-operation of this board, some of the companies connected with the inland route, in the course of the summer, reduced the charges upon their respective lines; and that subsequently there has been an evident improvement in the travel.

We omit, for want of room, the argument of the president in favor of vigorous measures being adopted to complete the road to the Ohio river. We may add, however, that it is, as might be expected from the able man at the head of the company, directly to the point.

The application of the power of steam upon the water and on land has already produced incalculable effects throughout the world. It is of too ready adoption, and too successful in operation to escape the attention of any enterprizing community; and all who expect to acquire superiority or maintain equality in agriculture, commerce and manufactures must rely upon its aid. *They must embrace the remotest points by the shortest distance and at the least cost of transportation.* Nature has placed the city of *Baltimore* within the shortest geographical distance of the trade of the western country; and any proper connection she may form with the Ohio river becomes as matter of course and above all competition, the direct and cheapest channel of communication, not only with the intervening country, but with the entire vallies of the Ohio and Mississippi rivers.

The growth and prosperity of any of our Atlantic cities depend upon the extent of foreign and domestic trade which they may be able to command; and these again require the facilities of a certain market, reached at the least cost, and offering the best prices.

To regain her former advantages, Baltimore must resort to the same artificial power by which they have been superseded—as stated in the last annual report, she must unite the power of steam on land with that on the water, from New Orleans to this city.

The successful operation of finished railroads judiciously located and economically managed between desirable points, is satisfactorily established by experience both in the United States and in Europe; and that a railroad from Baltimore to the Ohio river, comprehends the most important intercourse between the various parts of the Union will not be denied. While the considerations which in a public point of view, warranted the original enterprise have lost none of their importance, the board venture the opinion that the

capabilities of the work, and the claims it prefers to the public favor are already fully established. Wholly and peculiarly calculated to improve the trade and augment the wealth of every part of the State, they must continue to regard it as one of chief magnitude.

It is not to be disguised that many portions of the State, already heavily taxed for the maintenance of public credit, have little interest in any public work beyond what they incidentally derive from the prosperity of the commercial emporium; and if the Baltimore and Ohio railroad can in any sense be deemed a rival of any other enterprize, it can only be from its tendency to concentrate in the Maryland market the resources which by different channels would be diverted to other cities.

Already, in its unfinished state, it has imparted a new impulse to the trade and capital of the city of Baltimore. In the first year of its extension, after little more than ten months operation from *Cumberland;* subject to the rivalries of the works of other States at reduced rates of transportation, and without aid from the Washington road, it has earned a nett revenue of four per cent. upon the capital employed; and had it been extended, would have needed no greater amount of trade at prices which might have been charged without inconvenience, to have earned at least seven per cent.

Fully impressed with the necessity of making every exertion for the further prosecution of the work, it is a source of regret that, from causes beyond their control, the board have been unable during the past year to adopt any efficient measures for that purpose. The charter of the company both in Maryland and Virginia, by its original terms, is perpetual; but without additional legislation, the board had no authority, after the 4th of July last, to occupy any greater extent of the territory of either State for the extension of the road. Although the legislature of Virginia adjourned without removing this obstacle, the board have reason to believe that at the ensuing session an application for that purpose will be more successful.

In Maryland, the legislature allowed a further period of twenty years; but at the same time incorporated the permission in the law authorizing a sale of the public works, and in such manner as that, unless the State's interest in the work should be sold, the authority could not be exercised.

The board would not be unwilling to co-operate with the legislature in any equitable disposition of the State's interest in the railroad company; as a means of lessening the public debt, and to that extent effecting some immediate relief to the people from the burthen of taxation.

By the terms of the late law, however, there were grounds to apprehend that the period of twenty years would operate as a limitation, not upon the completion of the work only, but upon the duration of the *charter;* and that, notwithstanding the guarantee of a perpetual annuity of 30,000 dollars from the Washington road, the State would also be entitled to receive, in addition, one-fifth of the gross receipts from all passengers passing over the road to and from the city of Annapolis.

Under these circumstances, if in any other respects it had been objectionable, the board did not feel warranted in recommending the law to the acceptance of the stockholders.

From these causes, the board have been constrained to limit their measures for the extension of the road, to further reconnoissances of the country west of Cumberland through the State of Virginia, in the well founded belief that in that direction, should it become advisable to seek it, a better and cheaper route to the Ohio river may be obtained.

They also look forward with confidence to more auspicious legislation in both States during the ensuing winter; and it is their intention in that event,

in the same spirit which has animated them in the past, to take such measures, as with the resources adverted to in the last annual report, may enable them to recommence the prosecution of the work committed to their management. By order of the board, LOUIS MCLANE, *President.*

For the American Railroad Journal and Mechanics' Magazine.

To the Editors—Gentlemen—I have prepared, and respectfully submit, through your paper, to the consideration of the several railway companies of the United States, the accompanying form of a statistical table, intended for an annual exhibition of the character, cost and operation of their respective works. The collection and arrangement of railway statistics has heretofore met with serious obstacles in the irregular and incomplete manner in which most railway reports are presented to the public. Many details, essential to the derivation of general principles and practical results from the actual working of the railway system, are altogether wanting in their reports, and those particulars which are given, are often expressed and arranged so as to be useless, or available only at the expense of much time and labor. Believing that all railway companies would desire to make their reports as useful as possible, I have taken the liberty of proposing the present formula as a guide, which, if universally followed, will be eminently advantageous to them all individually; for each will have its contribution to the capital of knowledge, thus built up, repaid an hundred fold by the shares contributed by the rest. The value of this aggregation of the experience of the country, in this department of its institutions, will be incalculable.

I suggest, that in addition to the publication of this in the Journal, the tabular form be printed on a loose sheet, and sent forthwith to each railway company; and, thereafter, annually, a convenient time before the period of the publication of its annual report. The expense of this will be trifling to the Journal, to which most of these companies subscribe. Should any of them not see fit to attach the table to its annual report, they may perhaps be nevertheless willing to fill it up and let it appear in the Journal. Upon receiving all the tables from the several companies contributing them, a general table could be made out under the same heads, in which the contents of all the individual statements would be contained.

In the preparation of the form submitted, I have embraced elementary facts only, the proper deductions from which can be drawn by calculation. It is believed that no element, necessary to the knowledge of any important particular, respecting the work which may be under consideration, is omitted, while, at the same time, the companies furnishing the facts are asked for no more than is essential, as premises, to the conclusions which every one interested will draw for himself. The arrangement of the table may not perhaps be the very best, although it seems to make the most of the space included within the outlines. This is a matter of minor importance. The relative positions of the columns can be shifted to suit the judgment or taste of the party concerned. It is hardly to be expected, that the whole of these columns can or will be filled by all railway companies, some of which may

not have so kept their accounts as to render so minute a subdivision practicable. In such cases, approximations might be made which would answer the purpose, or, if these are out of the question, the specific detail called for will appear as a part of some more general heading. There may also be an unwillingness, in some corporations, to make so full an expose of their affairs as the formula calls for. From these causes the statements may not be as complete as could be wished, especially with regard to past operations. But, if imperfect, they will still be valuable to the extent to which they may reach, and should the form of record, now recommended, be approved of, they will for the *future* be as ample as is desired.

Knowing that you already appreciate fully the importance of this measure, and will not be backward in forwarding it, I now leave it in your hands, and remain, very respectfully, your obedient servant,

Baltimore, December, 1843. BENJ. H. LATROBE, *Civ. Eng.*

COLUMBIA AND PHILADELPHIA RAILROAD.

The following statement, from the Weschester, Penn., Republican, and Democrat, gives a more favorable account of the management of this road than we have before seen; and it, at the same time, establishes, beyond a doubt, the fact often asserted, that there has been *gross mismanagement* of its affairs, if not the most barefaced robbery of its funds, by those who have had the control of it. This statement shows a *daily* saving in the *motive* power alone, for a continuous period of *twenty-one* months, of $409 33, or $261,-440 27, when compared with its management from February 6, 1839, to February 28, 1842, a little over three years.

We would not be understood as intimating that the whole of this enormous difference between $760 18, the average daily expense from 1839 to 1842, and $250 88, the average daily expenses of the past twenty-one months, was misappropriated. There have been, or *should* have been, important lessons learned in the economy of managing railroads and their machinery, within the last five years, as we find by the annual reports of the different companies; not, however, in the ratio exhibited in this statement—yet it establishes the correctness of our theory, that it is true economy to employ, and pay *liberally*, none but men of *proved* integrity, and unyielding energy in the management of all public works—sycophants, *time*-servers and politicians *never*. Will not States and companies learn wisdom?

"Some time since, we requested of Mr. Morehead, the superintendant of this branch of the public works, that, at the close of the financial year, he would furnish us with an abstract from his annual report, showing the receipts and expenditures for the past year. In compliance with that request, he has communicated the following statement, which, with his accompanying remarks, cannot fail to be highly interesting and gratifying to every Pennsylvanian:

ABSTRACT STATEMENT,

Showing the total receipts and expenses on the Columbia and Philadelphia railroad, from December 1st, 1842, to November 30th, 1843—one year.

RECEIPTS.

Amount of road tolls collected, as per reports of collectors,		$199,274 51
Amount of motive power toll,		190,510 85
Amount due from post office department, for carrying United States mail,		2,733 33
Amount received for rents, and old materials sold,		2,173 48
		$394,692 17

EXPENSES.

For repairs of road, from Dec. 1st, 1842, to Nov. 30th, 1843,	55,082 09	
For maintenance of motive power during the same time,	135,292 99	190,375 08
Excess of receipts over all expenses, for the year 1843,		204,317 09
To which may be properly added the difference in value of stock in the motive power department, Dec. 1st, 1842, in favor of Dec. 1st, 1843,		9,481 38
Nett profit,		$213,798 47

"*Messrs. Price & Strickland*—The above statement may be relied on as strictly correct. The expenses of the year are greater than was anticipated; principally owing to the increased amount of business done this year, but which does not show a corresponding increase of receipts, in consequence of a reduction of tolls made by the canal commissioners, equal to about 20 per cent. on the whole business done. In addition to this, the expense of maintaining the State trucks to carry section boats over the road, the fixtures necessary to transfer them to and from the railroad and canal at Columbia, (which cost about 4,000 dollars,) are all included in the above expenses of motive power and repairs.

"It will be a matter of great gratification to the tax-burdened citizens of our Commonwealth, to learn that our public works are capable of producing a revenue equal to the cost of repairs and management, and the interest on the cost of construction. I confidently believe, so far as the Columbia and Philadelphia railroad is concerned, that, with proper management, no tax will be necessary to pay any portion of the interest on its cost, much less to pay the expenses of management. Yours, etc., "J. B. MOORHEAD, *Sup't.*"

We cannot permit the preceding statement to go, by itself, before the public, although in and by itself, it is entirely satisfactory. It is due, however, to the people at large, to the public interest and to justice, as well as by way of encouragement to faithfulness to duty, on the part of those engaged in the management of the State improvements, that a comparison between past and present management on this railroad should should be made. That comparison is exhibited in the following statement, based upon information derived from official sources, and others, in which, we believe confidence may be reposed.

STATEMENT.

Comparing the expenses of motive power, from Feb. 6th, 1839, to Feb. 28th, 1842; with the expenses from March 1st, 1842, to Dec. 1st, 1843.

Expenses settled in auditor general's office, up to March 31st, 1843, contracted undet the superintendency of Jas. Cameron and Thos. Tustin. See Senate Journal, page 291,	$810,154 43
Expenses settled since that time by present superintendent, under present creditor law,	17,708 28
Expenses paid since that time, by present superintendant,	21,260 63
Total expenses of motive power for 3 years and 22 days, as far as settled,	$849,122 33

Expenses from March 1st, 1842, to Nov. 30th, 1843, settled in auditor general's office,	$216,070 83	
Liabilities contracted during same time, and unpaid,	8,496 65	
Total expenses for one year and nine months,		$224,567 48
Average expenses per day, from Feb. 6th, 1839, to March 1st, 1842,		760 18
Average expense per day, from March 1st, 1842, to Nov 30th, 1843,		350 88
Difference per annum in favor of present management,		$149,394 50
Difference per month in favor of do.,		12,449 54
Difference per day in favor of do.,		409 30

For the American Railroad Journal and Mechanics' Magazine.

DURATION OF RAILROAD IRON—REMARKS ON MR. C. ELLET'S FORMULA.

I have noticed, with much surprise, that neither your valuable Journal—the Journal of the Franklin Institute—or any of our engineers, have yet questioned the formula of Mr. C. Ellet, in the position he assumes, viz, *that no flat bar railway can transport over it to exceed* 150,000 *tons, without the iron rails being crushed—destroyed*, and that even with the best T rails, such as are used on the Philadelphia and Reading railroad, he doubts their capacity to sustain the traffic of 800,000 tons without the necessity of their entire renewal. He uses the following language:

"The rails of the Reading road are, by common consent, acknowledged to be good; the pattern is considered, by the advocates of edge rails, to be unexceptionable; and the mode of manufacture adopted—that of making the lamina horizontal—is considered to render them almost proof against wear.

"In regard to these rails—with all their merits, and all their superiority— I affirm,

"1st. That they will not withstand the rolling of the trade of the Schuylkill for one year.

"2nd. That before 800,000 tons of coal have passed down and the empty cars have been returned on them, the present track will be entirely unfit for safe usage."

Perhaps our vision may be obscure from having taken up the opinion, some years back, that railways, such as the Reading, or a road to be located on a descending line from Buffalo to the Hudson, were destined to supercede—if not materially relieve—the profitable canals to which these lines are parallel, from the plethora of their increasing business.

In this State, the canal interests have "*black balled*" railways in legislative reports, and have stifled all inquiry into their merits, compared with canals. As we have a great respect for Mr. Ellet's talents, we would not wish to charge on him that the Schuylkill canal atmosphere of Philadelphia may have led him to view the cause of railways in the desponding vein he treats the success of the Reading railroad. If his positions be true, the capitalists of England, who have invested upwards of $250,000,000 in 1500 miles of road, and those of this country $100,000,000 in 400 miles completed have committed sad blunders. If Mr. E. is correct, in "using up" the flat bar after 150,000 tons has passed over it, or the *edge* with 800,000 tons, the sooner we burn up our rails, and send the iron to the blacksmith the better. The doctrine of Mr. E. goes to prove, that the more business done on railways, the worse they are off, while he roundly asserts that one year's business of the Erie canal, or of the Schuylkill canal, would annihilate the Reading railroad. It would appear, however, that while the Schuylkill canal,

during the last year, brought down from the mines 447,050 tons, the Reading railroad, with a deficient motive power, and cars, added to an insufficiency of double track in the centre, carried over it 229,015 tons—we, therefore, venture little in predicting, that ere two years, 800,000 tons will have passed over it, without any serious injury to the iron rail, and disprove Mr. Ellet's assertion of the durability of this road.

We draw this conclusion, from the fact presented in the "*Report of the managers of the Delaware and Hudson canal company to the stockholders*," published 7th of March, 1843, and circulated in Philadelphia, that over the $\frac{4}{8}$ to $\frac{5}{8}$ flat bar railroad, that connects this canal with the Lackawana coal region, there has been transported, without renewal, since it was laid down, in 1829, 1,627,250 tons.

We have not received the returns for 1843, from the Mauch Chunk and Lehigh railroad, but placing the quantity transported in 1843 at the same rate as 1842, we have since 1828, (when the light flat bar was laid down,) 1,794,611 tons carried over this road.

As Mr. E. calls for *facts* of the capacity and durability of iron rails, we would refer him to the Stockton and Darlington railroad, built expressly to transport coal, where stationary power is used, and the grades are fifty feet to the mile, and the load 65 tons. In a report prepared from parliamentary documents—quoted in "Sketch of a railway," p. 58—we find that the Stockton and Darlingtonrailroad has taken 690,000 tons and 200,000 passengers, or upwards of 700,000 tons in one year, an amount nearly equal to the destruction of the Reading railroad, according to the theory of Mr. E. We believe it is now more than ten years this road has exceeded the average of 600,000 tons per annum.

But we have a stronger fact in De Pambour, (appendix, page 288,) that certainly should have been before Mr. E. We allude to the experiment on the Liverpool and Manchester railway, where "a flat iron bar was laid down the 10th May, 1831, weighing 177 lbs. $10\frac{1}{2}$ oz.. It was taken up the 10th February, 1833, after having passed over it 660,000 tons. Its loss was $18\frac{1}{4}$ oz. or only $\frac{1}{165}$ of its primitive weight." At this rate, it would require, according to the language of De Pambour, "100 years to reduce it half its original strength."

With these facts, we shall leave Mr. E. to sustain his formula with his brother engineers and the public. We cannot, however, close these hasty remarks, without returning Mr. E. our sincere thanks for the research and classification of the several items of cost of motive power on railways, derived from the meagre reports that have heretofore been so common, even when prepared by legislative requirement. J. E. B.

For the American Railroad Journal and Mechanics' Magazine.

WEAR OF IRON RAILS.

In Mr. Ellet's paper on this important subject, there are one or two omis-

sions which I find it difficult to account for. In the first place, there is no allusion to one of the oldest railways in the Union, and in the State of Pennsylvania too, over which had passed during late years about 200,000 tons per annum; and during the 12 or 14 years of its operation, at least 1,500,-000 tons must have passed over this thin plate rail. The railway connecting the Delaware and Hudson canal with the mines, is the road referred to. If it be objected, that steam power is not used on this road, and, consequently, that it does not come within the rule, it must be admitted that the wear from the engine alone is more than ten times that of the freight; for Mr. Ellet says,

"The common half inch flat bar, under ordinary circumstances, is adequate to the transportation of about 150,000 tons of freight."

This is, of course, entirely out of the question.

In speaking of the South Carolina road, the iron is said to have been "destroyed." (page. 359) Had it been stated how many pounds per yard it had lost, or that it had been crushed or broken, some engineering information would have been given. But, unless my memory fail me, this iron was not only not destroyed, but was sold for a large sum, the company desiring a heavier rail for the increased business which was expected from the—at that time—contemplated extension of their road. Not having the official documents, I am unable to state the exact number of tons which have passed over the thin plate rail of the road first referred to, nor the amount which the "destroyed" rails of the South Carolina road brought in, with the price of iron at that time. Unless given by some other correspondent, I will endeavor to ascrtain the "actual" loss in the South Carolina road.

The mere fact that the rails on the Lowell, Camden and Liverpool railways have been changed, however important in itself, gives not the slightest information as to the absolute wear of rails; and it is worthy of remark that these changes have been most frequent on the most flourishing railways.

"In England, however, it is contended, people have more experience. The best experience there, is that of the Liverpool and Manchester railroad, a work which was opened to public use in the fall of 1830."

Here again the "par excellence" freight road of that country, the experience of which is worth more than that of all the other railways, perhaps in the world, is unaccountably passed by. The freight passing on this road is about equal to that of the Erie canal—upwards of 700,000 tons in freight and passengers per annum—and as the engines take only 65 tons per trip, the wear may be put down at twice that of a similar quantity passing over the Reading railway, where the engines convey three times as much at a trip. If the rails on the Stockton and Darlington railway are renewed every ten months, the old iron being comparatively worthless, then is Mr. Ellet's view correct. In the appendix to de Pambour it is stated:

"On May 10th, 1831, on the Liverpool line, a malleable iron rail, 15 feet long, carefully cleaned, weighed 177 lbs. 10 1-2 oz. On Feb. 10th, 1833, the same rail, taken up by Mr. J. Locke, then resident engineer on the line, and well cleaned as before, weighed 176 lbs. 8 oz. It had consequently lost in 21 months a weight of 18 1-2 oz. The number of gross tons that had passed on the rail during that time was estimated at 600,000."

Now, assuming, with Mr. Ellet, that the upper table weighs 20 lbs. per yard, it would require more than 12,000,000 of tons gross to reduce it one-

fourth in weight, on the supposition that this part of the rail is alone subject to wear.

The wear of rails has received much attention at various times, and Messrs. Knight and Latrobe introduced into their estimates of annual cost a certain amount to replace the iron rails. No particular number of tons was assumed, but, judging from the number of trips, about 4,000,000 would be a fair estimate.

I believe there are several roads with the plate rail, which have sustained the wear of 100,000 tons in freight and passengers, with a very insignificant loss in weight of iron—among the number, the South Carolina, and Hudson and Mohawk railroads. My object in writing, is, however, mainly to draw attention to the fact, that the oldest freight roads in England and the United States find no place in Mr. Ellet's paper, and that in the instance of the South Carolina road, the whole case is not stated, so that the reader is led to the most erroneous conclusions.

January, 1844. W. R. Casey.

Railroad Dividends.—We find in the Boston "*Shipping List*" the following statistics of the dividends of the Boston railroads for the last six months.

Roads.	Amount of Capital.	Amount of Dividends.	Dividends per Share.	Current Prices.
Lowell,	$1,800,000	$72,000	$4	$130
Worcester,	2,700,000	81,000	3	117
Eastern,	2,200,000	66,000	3	108
Providence,	1,800,000	54,000	3	108
Boston and Maine,	1,200,000	36,000	3	107
Nashua,	400,000	16,000	4	130
New Bedford,	400,000	12,000	3	107
Taunton branch,	250,000	12,500	5	120
Charlestown branch,	250,000	7,500	3	78
	11,000,000	357,000		

PRICES OF PORK AND POULTRY IN ALBANY AND BOSTON.

The Rochester Democrat has the following remarks in relation to the relative value of pork and poultry in Boston, Albany and Rochester. It says:

"On looking over the prices of pork, in Albany and Boston, we notice they are very high, compared with the markets in western New York. The reason is, that seventy-two miles of the railroad, between Utica and Albany, that connects us with Boston, is not suffered to carry freight. This is a great detriment not only to our pork raisers and wheat growers, but to all who raise a surplus of any kind of produce. Poultry is another article which always bears a high price in New England, and while our farmers are compelled to peddle it out here at four cents a pound, it is selling in Boston at ten cents. Could this winter embargo be removed, while the canal is closed, it would add thousands of dollars to the pockets of the farmers in this section. The west has suffered long enough in this respect. Prompt action should be had, and the Utica and Schenectady railroad company should be not only empowered, but *compelled* to carry freight in the winter."

We have frequently referred to this subject before, and urged the propriety

of authorizing the Utica and Schenectady railroad to carry freight, *especially* in winter, when the canals are closed. The advantage will be mutual to the farmers, and the citizens, and not disadvantageous to the company; as during winter, the travel is much less than in summer, and the engines are seldom required to take full loads, and may always take more or less freight.

It appears to us a narrow policy to construct important works, for the benefit of the people, and then to restrict them from doing that for which alone they were chartered. Our canals and railroads were undertaken and completed for the purpose of *facilitating* and *increasing business*, to enable the farmers to send their produce to market, and the merchants their goods to the country, at cheaper rates, and the result has been all that was anticipated —and *much more*, yet *not all* that they are *capable* of accomplishing—then why not require of them to extend their operations and usefulness to their full ability. We hope the legislature will be called upon to act on this subject at their present session.

ATMOSPHERIC RAILWAYS.

We find in the November number of the Practical Mechanic and Engineers' Magazine, the following description of the atmospheric railway; from which it appears that some interesting and successful experiments have been made on the west London line, at Wormwood-scrubs, and also on the Dalkey branch of the Dublin and Kingstown railway. These experiments are not given in detail, so that we can judge accurately of the practical operation of the system, yet they are referred to in a manner evincing no doubt of their accuracy by the editor. This result is in perfect accordance with an opinion expressed to us six years ago by Mr. Samuel Blydenburg, an intelligent practical mechanic, now deceased; who spake of its practicability as beyond a question, and of its extensive introduction as certain. In this account we are told that, not only the first cost of construction, but also the cost of working the road is greatly reduced; which, if true, is certainly a strong argument in its favor; yet, a stronger one in our opinion is, its *greater safety*— a consideration altogether above dollars and cents.

We give this article entire, and shall look with interest for further accounts in relation to the progress of a system, which may, at no distant day, say to the locomotive, as it has said to that noble animal, the *horse*, "your services are no longer required on this road."

More than a year ago, we intimated our intention of bringing this scheme under review; but as time passed on, the *experimentum crucis* on the Dalkey branch of the Dublin and Kingstown railway progressed, and at length attained a state of forwardness, which induced us to await the completion of the undertaking before hazarding any prophetic opinion respecting its general practicability, and the advantages claimed for it by its advocates over the plain matter of fact modes of propulsion at present in operation on our railway lines. The experiment has now attained maturity, and has already established, beyond dispute, this one important fact—that the scheme is possible.

But before proceeding to a description of the mechanical appliances by which this consummation has been realized, it may not be out of place to ob-

serve, that the principle of the scheme possesses much less of novelty than is commonly associated with it. Even two centuries ago, the notion was entertained of producing motion economically for the purpose of transit by means of the pressure of the atmosphere. The original thought may, at least, be traced back with certainty to the celebrated Dr. Papin. In succession, long afterwards, came Lewis, Vallance, Medhurst and Pinkus, whose speculations excited in their day, some attention and more ridicule. Many of these are curious, and none of them are more absurd than that of Vallance, who actually proposed to propel his carriages and passengers through an exhausted tunnel.- Medhurst, in imitation of Vallance, in his first speculation, proposed likewise to drive his carriages through a subterranean passage, but believing that his passengers could not comfortably exist without air, made provision, at least partially, for its supply during the passage. In a pamphlet which he published in 1817, he describes his line of transit as a "hollow tube" of such dimensions as to admit a four-wheeled carriage to run through it, and to be constructed air-tight of iron, brick, timber, or other "suitable material." The carriage was to be of a form and size nearly to fill the cross section of the tunnel, and to be propelled forward in one direction, by forcing air into the tunnel behind it, by means of a stationary engine, working a huge air-pump; and in the other, by exhausting the tunnel in advance of the carriage, and allowing the pressure of the atmosphere to act upon it behind. The proposal was received with ridicule, and for a season afforded good material for the caricaturist. But Mr. Medhurst was not abashed; nor was his ingenuity exhausted, for he speedily devised means of propelling his carriage in the open air, and of making a communication between the interior of his propulsion tube, and the outside, preserving it at the same time air tight. His scheme now began to assume a rational form. Its principal feature was the exchange of the subterranean tunnel for an iron pipe of 24 inches diameter, having a longitudinal opening on its underside, between two flanges of six or eight inches deep. These flanges were to be immersed in a channel of water, thus forming a species of water valve, throughout the whole length of the pipe. It is unnecessary to say, that this valve did not answer, but it was an approach which seems rather to have whetted than damped the ardor of the inventor, for he immediately discarded it for one formed on the top of the vacuum pipe. In this modification, the pipe had no flanges along the opening. The valve was a metal plate, hinged to one edge of the groove, and had some soft substance as leather, fixed upon the other edge, to shut against a seat of a similar material, fastened on the corresponding edge of the groove, so as to form when shut, an air tight joint. The power was in this case as before, to be obtained by exhausting the main by an engine at one end, and to allow the pressure of the atmosphere to act upon the back of a piston accurately fitted to the pipe, and having a projecting arm passing through the groove; to this the carriage was to be attached. The piston had certain attachments for opening the valve as it advanced, and others for shutting it; but withall the valve was not tight.

In this advanced state was the contrivance, when taken up by Mr. Penkus, who suggested the rope valve, which likewise failed to keep the tube air tight, and was in turn abandoned. The course being thus clear, and the notion reduced in some measure to a practicable form, Mr. Clegg steppeo forward, and solved the difficulty. He has deviated in no respect from the general arrangement suggested by Mr. Medhurst, but by a closer attention to the conditions of the problem and the mechanical details which these involve, has succeeded in working out the original suggestion to practical util-

ity in a way which promises to be efficient, and capable of enduring the rough usage necessarily attendant on constant and rapid motion.

The atmospheric railway in its present state of development, consists of a cast iron pipe, laid in lengths, like water and gas mains, between the rails of the line, and attached to the cross sleepers which support them. On the top of this pipe is a narrow longitudinal opening, which for the purpose of rendering the pipe *pro tempore* air tight, is covered with a valve as suggested by Mr. Medhurst. This valve is a simple flap formed of a slip of leather rivetted between narrow plates of iron—the plates on the exterior side being flat, while those on the under surface are of a segmental form to complete the inner periphery of the tube when the valve is closed down. On one side the leather is fastened down to a longitudinal rib, cast along the opening in the pipe, and being flexible, forms a species of hinge. The other edge, when the valve is shut, falls within a ridge cast upon the pipe, and forms with it a channel which is filled with a composition of bees' wax and tallow. This substance when melted into the channel cements the valve in its place, rendering it to the necessary extent air tight. The tube is of the same diameter throughout, and has a piston fitted into it likewise made air tight, by leather collars. At the end of the rod of the piston is a counter weight to keep the rod, which is about fifteen feet in length, parallel to the axis of the tube. Upon this rod is also a frame which carries four wheels, the use of which is to open the valve as the piston advances in the tube. To it is also attached the *coulter*, which is formed of strong plate iron, and projects through the longitudinal opening in the pipe, forming a connection between the piston and the leading carriage or guiding truck of the train moving upon the railway. The tube being exhausted in *front* of the piston by an air pump worked by a steam engine, the piston is acted upon behind, and impelled forward by the air, which finds admission into the main by the opening of the valve on the passing of the coulter. This opening through which the coulter passes is raised only a few feet in length at a time, and *not* in advance of the piston. By the operation of raising the valve out of its seat, the packing is broken; but the air tight contact is again immediately reproduced, when the coulter has passed. The first part of this operation is effected by a wheel attached to the guiding truck, which operating by a spring, presses the valve into its place, where it is cemented by a hot copper slide, about five fieet long which passing over the surface of the composition in the groove at the valve edge, renders it partially fluid. The valve being thus opened and replaced air tight as before, the tube is left ready to be again exhausted for the next train.

The main pipe is prepared inside to receive the piston in a very simple and economical manner. On the castings being taken from the foundry sand, a cutter is passed through them; this if followed by a wooden piston, which spreads the unguent in a complete coating of even interior surface. By the frequent passage of the working piston, this tallow lining, or tinning as it were, becomes perfectly smooth and nearly as hard as Paris plaster, so that the piston may be considered, practically speaking, to work in a tube of tallow protected by the iron pipe as a casing.

In this mode of propulsion, it is clear that the measure of the power for producing motion is the product of the sectional area of the main pipe multiplied by the number of pounds pressure due to the vacuum. Thus from a tube of twelve inches diameter under a vacuum of eighteen inches of mercury, giving nine pounds pressure per square inch, there is obtained an atmospheric power of fully 1000 pounds—a result equivalent to the *average adhesive* power of a locomitve engine; and capable with due deduction for

friction and resistance of all kinds, of propelling ten carriages of 46½ tons over a horizontal railway; and two carriages of 9½ tons up an incline of so steep a gradiant as 1 in 28. On the West London line at Wormwood scrubs where the atmospheric system has been in constant and successful operation under very disadvantageous circumstances, on a length of half a mile, for the last three years, the main pipe is only nine inches diameter. Up this line, which is an incline of 1 in 120, loads of 13 tons have been propelled at the rate of 20 miles an hour. On the Dalkey branch of the Dublin and Kingstown railway, the tube is 15 inches diameter, and the gradient of the incline is 1 in 110. Up this three carriages loaded with passengers, have been propelled over a distance of 1¼ mile, at the rate of 40 miles an hour.

With regard to the velocity attainable by trains impelled by atmospheric pressure, it may be regarded as independent of load and pressure, and regulated almost entirely by the proportiion between the area of the tube and that of the exhausting pump; that is, by the velocity with which the air is withdrawn from the tube by the pump; the exhausting pump piston travelling, at the same speed as the piston of the steam engine which works it; that is, not exceeding three miles an hour. If the trains are required to travel at the rate of 30 miles an hour, then the transverse sectional area of the air pump must be to that of the pipe as 10 to 1, and the engine power must be provided accordingly. This is independent of load; and gravity being practically an equivalent augmentation of the load to be moved, it is consequently also independent of the gradient. In practice, atmospheric leakage must be taken into account, and additional engine power provided for it; this is computed to be at the rate of six horse power per mile of pipe.

To illustrate this still further: suppose the travelling load to be 50 tons, and the degree of vacuum necessary to obtain a given velocity, producing a pressure of 10 pounds per square inch on the piston; so long as the load is the same and the line level, the train must move with equal velocity, because the speed is due to the rapidity with which the air is pumped out of the pipe. But if the load be only 25 tons, starting with the same pressure as with 50 tons, the train then runs faster than the air is drawn out of the pipe, the power behind being so great in the first instance, as to force the load forward at an increasing rate. But the pump going slower in proportion than the train, the air gets packed as it were in front of the piston, and becoming less rarefied, must offer greater resistance; the velocity of the train, at first greatly increased, gradually diminishes, until the amount of vacuum becomes proportionate to the weight behind it: the train then goes on uniformly. Again, supposing the train to start with a load which is rather heavy for the degree of vacuum, it moves at first with less required velocity; but the air in this case being withdrawn quicker than the road follows, the vacuum becomes more and more perfect; and thus the power increasing gradually, the train increases its velocity until it becomes balanced with the vacuum. To ascend an incline, may be called equivalent to adding to the load, and to descend equal to diminishing it; when the train therefore coming to an incline, begins to ascend, its rate will gradually diminish until the power is brought up equivallent to the pressure; that is, until the exhausting pump by going faster than the train, generates a power sufficient to impel it up the ascent. In descending inclines, the trains will start with increased velocity; but the vacuum will immediately begin to diminish and reduce the effective pressure behind. The moment the train comes to the level, its velocity will begin to increase till the balance is again restored between the velocity and pressure. Messrs. Glegg and Samuda, the patentees of the atmospheric railway, purpose to work their lines generally by stationary power, erected at intervals

of four or five miles apart; and to work the different inclines by corresponding degrees of vacuum. By this means they calculate on a large saving of first cost in the construction of railways on their system, and also in their maintenance. The former of these items they estimate at about £22,000, and the latter at £1,460 per mile below the average cost of formation, and expense of working upon the locomotive system. In this, however, it must be observed, the average cost of construction is taken at £37,000 per mile, whereas some of our most important lines have been laid down for one-third less, and it has been shown by Mr. Lock, that a very important line, the Caledonian, may be made for £17,000 a mile.

The most important of the two savings claimed is that in the annual expenditure; and it must be admitted, in looking at the enormous sacrifice of power and materieal in our locomotive system, that there is much room for economy in this department. By the application of stationary power—and this, in many, if not in most cases, might be water power—on the atmospheric system there is nothing to be propelled except the carriage, and a near approximation to the full dynamical effect of the force generated is obtained. On the locomotive system, half the load on the average of trains consists of the engine and tender; and on the stationary system of traction by rope and pulley there is a large expenditure of power in draging the rope along, in bending it round the drums, working the pullies along the line, and overcoming the friction of the other parts of the attendant mechanism. On the atmospheric system, is substituted a rope of air, without friction or weight, and capable of transferring a power that may be called inexhaustible and boundless.

But on this subject we have not as yet obtained sufficient practical data to waraant a strict comparison. We know that the locomotive system is expensive in the extreme, and that the mode of traction by rope and pulley is attended with practical difficulties and inconveniences, which prevents its adoption wherever it can be avoided. A short experience on the Dalkey branch, now on the eve of being regularly opened, will decide the question to full satisfaction; we await the result with some confidence.

In conclusion, we may remark that the atmospheric system seems to hold out one paramount advantage in its perfect safety from collisions and similar accident, which on railways, even with double lines, worked by locomotive engines, are always liable to occur.

Since the above was in type, a Dublin correspondent writes that the trains on the Dalkey branch have been running regularly with perfect success, during the last three weeks, (Nov. 10th,) and that a speed of fifty miles an hour has already been obtained. So elated are the promoters of the atmospheric system, that arrangements are in course of preparation for extending the line to Bray.

The series of communications from Charles Ellet, Esq., C. E., in several of our late numbers has attracted much attention and remark. From various quarters we have been urged to make some comment upon these articles expressive of our dissent from the positions of Mr. Ellet. For several reasons we have abstained from doing so, and chiefly because—differing as he does from many, if not most of the other distinguished members of the profession—we wished that his opinions should be heard without any bias, and without any note or comment on our own part. This end has now been answered, and we feel at liberty to express our opinions with the same fredom which we have always felt disposed to grant to others.

views, no matter how warmly,—provided this is done with decency and propriety—we not only cheerfully give place to him, but *urge* a continuance —convinced that if any error is advocated, it can easily and readily be refuted by members of the profession, all of whom are welcome to our pages. Moreover, the discussion of error, if not childish or trifling in its character, is sure to end in good; and when the life and soul of the railroad system are at stake, it certainly must prove an inducement for *some one* to engage in its defence.

In several previous articles we have alluded to the manner in which this subject should be discussed, and we must confess that Mr. Ellet has approached more nearly than any one else to the spirit in which we desire to see the question taken up. We differ from Mr. Ellet, however, as to the value and correctness of his data, at least in one of the most important points —the deterioration and wear of iron. The articles of Mr Ellet show a vast deal of research, and labor; they are therefore entitled to a respectful and careful examination. But if the whole amount of railroad statistics in our possession had been used as data in the formation of the rules or formula proposed, much more general satisfaction would have been given. Fortunately, the precise and systematical method of Mr. E. allows of the readiest correction of his own errors, for such do undoubtedly exist.

The great and vital mistake, in our opinion, is the enormous, and as we imagine, unwarranted amount of deterioration assigned to railroad iron. We do not hesitate to say, that if the opinions—for they are but opinions— of Mr. Ellet are correct upon this point, the whole railroad system in this country must fall to the ground, and in Europe should by this time have already been abandoned. This is not the case, and we have from this circumstance alone a reasonable doubt as to the correctness of the position assumed by Mr. E. His data for this are taken from two roads, in themselves unfair examples, and not correctly stated. Any inference, based upon so narrow a foundation, and leading to such momentous consequences, has been well characterised by a celebrated writer as an inverted pyramid, with the apex to the ground—a fair case of unstable equilibrium.

But it is not our intention to enter into this discussion, which should be, as we have before said, based upon strict argument upon *all* the data in our possession. If the cause of railroads in general is at stake, its defence certainly must depend upon better qualified and more influential advocates than ourselves. The pages of this Journal are open to all, and we urge upon all concerned to take part in the settlement of the most important question ever presented to the profession. It is not in our power at present, even if so disposed, to fight single handed the battles of railroads in general; in this matter we feel quite independant; we are under no obligations to railroads generally, and all our labors on their behalf have hitherto been so miserably ewarded, that we think it a hard case to fight without pay and furnish our own amunition in the bargain.

We have wished to express our own individual opinion, and having so done, we open our pages to all who are disposed to enter into the argument —only asking for fair play on all sides.

RAILROAD REPORTS.

It has been a common remark by many deeply interested persons, that the *manner* in which the annual reports are made, by railroad companies, renders it all but impossible to arrive at a correct understanding of their details. There is seldom such a classification of the various items of expense as will enable an uninnitiated or unprofessional reader to arrive at the true results; consequently the great majority of the stockholders, and others who may desire to become such, are unable to judge whether it is safe for them to hold or to purchase stock in such companies. Another common remark is that there would be great convenience if the reports of all railroad companies were made, as far as possible, in tabular form,—so that the various items of expense shall always be found in every report, in the same place, and under their appropriate heads; and we speak the sentiments of thousands, when we say that much benefit will result to the cause of railroads by the adoption of a tabular form of report which shall give each item of expense under its appropriate and distinct head.

Our views upon this subject have been more than once expressed in these columns, and repeated calls have been made upon those gentlemen, whose experience in the construction and management of important lines, will enable them to draw out a form, comprising all the requisite heads, for publication in the Journal. As will be seen in this number, our call has been responded to in a manner highly gratifying to us, and we think it will be found an exceedingly comprehensive and valuable document to the profession; and we venture, in their behalf, as we do most heartily in our own, to thank Mr. Latrobe for preparing it. With this form before them, we hope each railroad company to whom it may be sent—and we shall send a copy of the Journal containing it to the president of each road, both in this country and in Europe, where we can obtain the proper direction—will adopt the form in making their reports, and send us a copy at their earliest convenience—that we may make out a general table, exhibiting at one glance, a comparative statement of the expenses on all railroads. Such a table will be useful, as it will lead to a more rigid economy, and to great reduction in many items of expense.

If desirable, we will furnish the different companies with these blanks, in such numbers as they may desire, at any time, without delay, on receiving their order, as it is stereotyped.

☞Subscribers will please recollect that this number commences a new volume; and they will do well to apply soon for missing numbers of the past volume. Those who are in arrears for subscription will relieve their own consciences, and our *necessities* by an early remittance.

ERRATUM.—Article—"Duration of railroad iron"—8th line from bottom of page, for "400 miles completed," read 4000 miles completed.

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For the American Railroad Journal and Mechanics' Magazine.

REMARKS ON MR. ELLET'S FORMULA—COST OF TRANSPORTATION ON RAILWAYS.

In the December number of your Journal, my remarks on this formula of Mr. Ellet's, were perhaps sufficient to show that it was not possible to construct one, which could be of any practical use for determining the present value of any specific railway, and still less of one in contemplation, the constant tendency towards amelioration in all the departments of this improvement, rendering the data of to-day no longer applicable on the morrow. It was there also shown, that in the very nature of the railway, the condition is implied that it must always be kept up in full repair, the neglect of this condition leading to its abandonment by the public, and the consequent ruin of the concern. Hence like old wine, a railway should be and generally is, all the better for its age, and it may be broadly asserted, as the *result of this condition*, that there is not one of our earliest railways of any note, which is not now better than it ever was, and is, moreover, daily growing better in some one or other of its details. Even in the case of the *Columbia*, a Pennsylvania *State road*, this is strongly exemplified, the daily expense of management being reduced to $350 per day in 1843, as compared with $760 per day in 1839 and 1840, the result as well of improvements as of better economy. Every railway must thus stand on *its own merits*, no two being found sufficiently under a parity of circumstances to admit of the one being any rule for the other, this being long since received as an *axiom* with all intelligent railway engineers.

I shall now continue my remarks upon the further article which appeared in your December number, from Mr. Ellet, in support of his formula.

In the first place he gives another table of the repairs and expenses of engines and cars for several roads, which is good, so far as it shows a variance in this item of from five to ten cents per mile run, or of 100 per cent.; but of what use is an average for *particular application* from such extremes as this?

In the next place he gives another table of the repairs and expenses of cars and engines for several roads returned in *one item*, on which he pro-

perly remarks, "it is the custom of many companies to publish the cost of repairs of their engines and cars in a specific item, so as *to make it impossible* for the reader to determine from their accounts what portion of the bill was created by the engines, or the difference between the repairs due to different sorts of cars." Nothing daunted by this incongruous mixture, he proceeds with his deductions, and *to fix* laws for these expenses, giving and taking as it suits his purpose, and reduced also occasionally to the hard necessity of being *obliged to suppose.*

A seeming approach, now and then, to some agreement between the *actual* expenses and the *calculated* ones, by his formula, has naturally the effect of misleading him, when it is only the result of accident, and comes from the roads compared by him being nearly all alike in the *small ratio* which the actual business done by their establishments and machinery, bears to the *much greater* amount they would be equal to, did the business exist for them. This feature is strongly marked on all his tables, and is at first inseparable from a railway, which in itself and its equipment must be a good deal ahead of the business existing for it at the outset, but as experience shows that under the influence of a railway, this business has a constant tendency to expansion, while at the same time all the parts of the machine, getting to be worked more in unison and towards the one single purpose of economy, its earnings increase, and the proportion of its expenditures diminish. This has been signally manifested in the case of the Columbia road just adverted to, as well as in that of perhaps the earliest pioneer in this improvement with steam power, the Baltimore and Ohio railway, which, after narrowly escaping the trials of infancy, has been of late years gradually approaching towards a *fullness of business*, and of this even Mr. Ellet could not help being struck, when he remarks, that the *actual* cost for the road falls considerably below the *computed* cost for 1843, but without perceiving, or being willing to acknowledge, that it was owing to this expansive tendency; another remarkable instance of which I find in the Georgia railroad report for 1843, in which it is stated, that with an increase of only 353 miles run by the engines, it delivered in that year 23,000 bales of cotton more than in 1842. At this rate Mr. Ellet's formula would be kept for ever at fault. In England, in the midst of its dense population and business, few railways suffered long in a disproportion of their establishments, and the work for them to do; but here, in this country, where these essential elements of success are sparse and small, much disappointment had to be suffered and patience borne, before in most cases, that evil could be overcome. This expansive principle is ever active on railways, and, under *low charges*, being more particularly influenced by it than any of its rivals, its chances of survival and of ultimate triumph are generally the best in cases where it may have to contend against strong and unusual competition, and the business is not more than enough for one. No better evidence can be adduced of any extended confidence with the public in this improvement, than the rise in the stock of most railways, the Reading included, in the last few months, some of them bearing the high-

est premiums of any on the stock list. While on this part of the subject, we cannot do better than quote what is said of it in England, where the interest being large, it is likely to be best understood, and where the most unbounded reliance on its permanent safety as a profitable investment is being constantly manifested, which could not be, either there or here, if Mr. Ellet's theory were true.

"Other things being alike, if the receipts are higher, the percentage of expense will be less—and vice versa; again, the more business, the less in proportion is the expense at which it can be done, simply because the standing expenses will bear a less proportion to the receipts when great than when little. In determining the comparative value, or the per centage of profit on different lines of railway, the first consideration is to look at their respective amounts of capital, as the smaller this may be, the more likely is it to pay well. This is affected by many circumstances, not always controllable, but in respect to which it is now only of use to remark, that after a vast amount of dear bought experience, the first outlay can now generally be kept down to a saving of one-third of the old limits, and for a very superior article. Between recently built railways, and still more so with those which may be contemplated, and their pioneer progenitors, comparisons in first cost and in useful and profitable effect will no longer hold, where they connect equally suitable points."

Thus for England at least the railway system is considered not only permanently safe, but can be relied upon as continuing to maintain a progessive career. Here, however, this encouraging view is not so general, and the counter interest of canals, is forever busy in repressing it—and not satisfied with endeavoring to make it the most self-devouring machine by its ordinary expenses. Mr. Ellet thinks he has brought against it a "wear of iron," which alone would be beyond compensation by any probable amount of business, and under which the whole system must inevitably break down. But on this main item of the *wear of the rail* let me quote his own words, that he may not be misunderstood.

As a sort of summary of his views on this head, he remarks:

1st. "That great errors have been committed in the consideration of this subject, in overlooking the fact, that the progress of the wear is rarely ascertained, or in the least appreciated, until the rail is destroyed. The annual charge for iron is very small, because in general the track does not appear to give way until it is nearly unfit for use. When repairs really commence, the destruction is so far advanced that the iron must be renewed, and if the directors assert, as they usually do, in their next report to the stockholders, that experience has shown that the original iron is very bad, and has all been crushed, the explanation is satisfactory, and the cost of the new iron is forthwith charged to the account of construction."

In order to show the estimate of loss he has arrived at on a particular form of rail, and after distinctly stating that he considers the so called improved edge rails as *more perishable*, he remarks,

2d. "That the common half-inch flat bar, under ordinary circumstances, is adequate to the transportation of 150,000 tons of freight. Such a bar on the Petersburg road, where the freight amounts to some 25,000 tons, would resist the wear of some six years' business; but if the trade of one year of the Schuylkill canal (say 7 to 800,000 tons) were poured along it, the iron part of the track would need entire renewal six times in one year."

But few of our readers can fail to be struck with the novelty of the idea in the first quotation, that the destruction of a rail thus steals upon one like a thief in the night, and not being in the least appreciated, until the *whole track* breaks down at once; and still more novel will it seem to them, that the cost of renewal is all supplied forthwith in a lump, by merely *asking* for it. This is a readiness of means, which few, if any, of our railways ever suspected themselves of possessing, under ordinary circumstances; and under

such effects as Mr. Ellet attributes to a Schuylkill *freshet of tonnage*, not one of them would hope to escape, in the *money* line, *utter extinguishment*.

In my own justification, however, I should state, that I doubted much whether these quotations should be treated seriously, as carrying in them their own refutation; but as the public in general look but seldom into this subject, or have the means of much correct information in respect to it, I have thought it as well to show that it is only by an entire ignorance or perversion, through misunderstanding I hope, of the facts in the case, that Mr. Ellet has been able to concoct such results.

Everybody knows more or less of the origin of steam railways for the purpose of quicker travel and transportation. Not knowing better, they commenced with a light plate rail, but soon found out, that the stringer or *continuous support* it required, could not be kept continuous, but was forever decaying and leaving the rail unequally, by which it was sooner or later bent into ridges, according to the weight of the then more destructive locomotive. This soon induced the use of a thicker flat bar, and so on from the plate rail of 15 pounds, the weight has been gradually increased to 80 pounds per yard, disposed of in various shapes to produce the greates possible strength, principally to meet a continued increase, until lately in this country, of weight of locomotive, the best form of rail for this purpose being yet an open question, and in which further improvements will continue to be made as suggested by experience. It is in the course of these transitions during the last fifteen years, from light to heavier rails, in search in fact of the *adequate*—and towards which, in England, the Liverpool and Manchester, as the pioneer, contributed so liberally—that Mr. Ellet has thought to find his cases of destruction, and to assume upon these mere replacements of a heavier for a lighter rail, that a serious *dead loss* was incurred, when in fact the old and *merely defaced* iron often, in the case particularly of the flat rail, always realized first cost, and sometimes a profit; that on the Mine Hill road having, as one instance, sold at $70 per ton. Here, then, is found the true version of the several cases of rails destroyed, as adduced by Mr. Ellet, and that this is so, as well as that there may exist not even a *shadow* of ground for the very perishable character he attributes to it, but on the contrary, that it has abundantly proved itself to possess a suitable durability, I subjoin a list of roads on which the rails were laid *some time prior* to those cited by Mr. Ellet as long since destroyed, which are *still in use*, and likely to remain so until the concerns can afford to change them, or for an indefinite period. The following are those, among several others, that I will refer to, as having still down their original iron, either in whole or in part:

The Mohawk and Hudson,	Flat rail	In use for	10 years,	Steam power.
The Baltimore and Ohio,	do.	(40 miles of old track)	12 "	"
The Harlem railroad,	do.		11 "	Horse and steam power.
The Utica and Schenectady,	do.		7 "	Steam power.
The Columbia road,	Edge rail		9 "	"

All these roads have had their iron put to the severest test, the Harlem in particular, over the city part of the track, some 300,000 tons in human flesh and cars passing annually, and which must by this time have borne over one

million of tons. The other roads have all been battered by the heaviest locomotives, and made to suffer especially on their curves, from which few are exempt, and although made no account of by Mr. Ellet, are the most fruitful source of wear and tear to both road and machinery, particularly on th Columbia railroad. But as establishing the fact of the little injury sustaine by the flat rail from the rolling of mere tonnage over it, we find by referenc to their reports that there have passed up to this time over the

Mauch Chunk Lehigh railroad	in coal	descending and	ascending cars	a tonnage of	3,160,000	tons
Lackawanna	"	"	"	"	2,600,000	"
Mine Hill	"	"	"	"	1,600 000	"

Now as the rail could save nothing by *rest*, the wear would be the same had the above tonnage passed over it in *a month*, or in a *series of years*, and therefore for Mr. Ellet to assert that such a mere *bagatelle*, comparatively, as 150,000 tons, would destroy the Petersburg rail in six years, and that the tonnage of the Schuylkill for one year, about one-fourth of that already passed over the Mauch Chunk road, would require it to be renewed *six times* in one year, is utterly preposterous. Neither do the parties concerned in the above roads entertain a doubt of the iron on them continuing to be useful for many years to come, all of them showing annually an increased transportation. But what is most singular, is to find Mr. Ellet maintaining that all the world have been asleep in this matter of the sudden breaking down of the iron on railways, and that as it were, it has been left to him to give the first alarm and wake them up. It would indeed be marvellous, if at this late day, no notice had been taken of this very important fact, or that it would not indeed have proclaimed itself and have arrested the further prosecution of the railway, particularly in England, where the iron is treated without mercy ; as regards weight of locomotive, length of train and above all in the highest speeds—30 miles for travel, and 15 miles per hour foı freight. What took so many of the Continental engineers to England, and afterwards brought them here, but to learn how it stood in particular, in re spect to this *vital part* of the system. And does not the spread since of railways over all the Contenent, establish the fact, that the cost for renewal from wear of the rail, as I stated in my former remarks, was ascertained by them to be compassable by a *moderate* annual charge after allowing for old material, generally worth two-thirds of the new ; and this *without limit* to the trade to be passed over it? This being most particularly important to the Continent, where iron is generally expensive, pains were in consequence taken to be sure of the fact. The latest reference we can find to the subject in England, where it is now no longer matter of concern, is in a lecture of Professor Vignoles, and he there says:

"That the result of a variety of experiments on the malleable iron rails of the Stockton and Darlington colliery railway gives one-tenth of a pound per yard per annum, as the absolute amount of fair abrasion. Some statements, however, made it much higher, being one-sixth of a pound per yard. On the Killingworth colliery it was one-eighth of a pound. On the Liverpool and Manchester some years ago, the wear was found constant at about one-tenth of a pound per yard per annum. At this rate it would take 100 years to wear away a rail from mere abrasion; but later experience shows that the increased weight of the locomotive acts very destructively on rails whose upper webs are not sufficiently stren-

and of the best manufacture. We may take ten tons as the present average weight on one pair of driving wheels of English locomotives."

The colliery railways here alluded to by him pass annually 700,000 to 800,000 tons by steam power, and confirm the experience here that from mere abrasion the loss to the rail is the merest trifle, and which is only of any moment, when in the case of *inferior iron* it is liable to be partially torn and exfoliated by the slipping, principally on the *curves*, of heavy locomotives. A good deal of bad iron of both flat and edge rails was at first imposed on railways, both here and in England, forming the exception and not the rule in the case. This arose partly in the attempt of the English to make as cheap rails as the Welsh manufacturers, without having as good mineral, and leaving out some of the refining processes, and this was not at first so much cared for, until the hammering of the locomotive taught them that the top tables of the rails at least could hardly be too good and malleable, and to these the proper degree of toughness is now given. In England the iron on railways is like the wood in this country, cheap and not so much an object, and hence they could be liberal in the weight of rail, rather than seek to diminish that of the locomotive, which would there involve a loss of power they could not afford. But here our interest has been to economise iron in the rail, and to this end all the mechanical ingenuity in this line has been turned, until the desideratum has been at last attained of making *all the weight* of the engine *useful*, at the same time, so distributed that with treble the power of the old style of machine, it presses but little more on the rail than an ordinary car—that is, the pressure from any *single* driver need not exceed two tons, while in England it is four to five tons, with only half the efficiency. The economy of this improvement must pervade the whole system, and may be said to make a new era in it, at which Mr. Ellet's formula, based on old or obsolete data, must cease to be applicable, if at any time it were good for anything. The thanks of all the lighter roads and with unfavorable grades, and indeed of all sorts of railways are fully due to Messrs. Baldwin and Whitney for this their latest ingenious effort; and many have already given more substantial proofs of acknowledgment, by the adoption of this admirable engine, and all of them, after several months *trial*, testifying to their unequivocal superiority. It will be at once perceived how great may be the saving of iron on a road using these locomotives, with which 50 pounds to the yard would be our maximum.

I would here notice the very crude notions entertained commonly as to the relative cost of transportation on a railway of passengers, merchandize, minerals and other heavy products, the impression being that *travel* is that which costs least, when, according to Professor Vignoles, whose experience is not small, he states it to be *twelve* times dearer than *minerals*, and *six* times dearer than merchandize, carrying weight for weight, or reducing them all to tons. This, in the case of minerals, as coal, arises in its being the only species of transportation which *always* affords *full loads*, and the saving generally in the comparatively *low speed* at which it is carried; and

this explains why the *colliery* railways in England *pay best*, notwithstanding the very low rates at which they carry, even with indifferent gradients and for their weights, comparatively inefficient engines for so doing. Some there are, who, when its carriage is associated with a railway, entertain the school day notion, that a ton of *coal*, in particular, is *heavier* than a ton of *feathers*, when in fact the latter, not any lighter of course, is the more *cumbrous* to carry, as may well be imagined of a train of 900 to 1000 bales of cotton, now a common sight on our light southern roads, since the introduction of the locomotive just alluded to, and equal to 320 tons gross load, over 30 and 37 feet grades, at a speed of 10 miles per hour, the engine weighing about 12 tons on 6 drivers.

It would appear, however, that the great aim of Mr. Ellet, in all this statistical diligence and research, is to prove the certain failure of the Reading railway, in its present attempt to wrest the coal trade from the Schuylkill canal, to which it runs parallel, between Philadelphia and Pottsville. If railways could be kept in a state of infancy, and confined to mere travel and a *small amount* of freight, Mr. Ellet's attention might not perhaps have been aroused; but this is not so, and as he expresses it—"Railways are now constructed to take the place of important canals, and to furnish the means of transport for the *heavy products* of the earth at *exceeding low* rates." As the consequence of this attempt of the Reading railway, Mr. Ellet asserts,

1st. "That it will not withstand the rolling of the trade of the Schuylkill (7 to 800,000 tons) for one year.

2d. "That it will cost from 50 to 75 cents to replace the iron which is destroyed by each ton of coal that descends from Pottsville to Richmond on the present track."

As to the first assertion, the testimony already adduced by me, proves the flat bar rail to possess sufficient durability, and might suffice for all other forms, but as the rail on the Reading road is of the edge pattern, and pronounced by Mr. Ellet to be the *feebler* of the two, it will be useful to show that this, like all else that he asserts of the railway, is marked by the same inverted and therefore perverted, view of the subject, which misleads him and all kindred reasoners, while the improvement is *flourishing* all around them, into the mistaken belief that its days are nigh being numbered. It happens, unfortunately for him, however, that this very Reading railroad already furnishes itself the test of a competency far beyond what Mr. Ellet would allot to it, and comes very apropos to the overthrow of his kind prediction of its early fate.

Thus the *records* show that from its opening at the end of 1838, to the end of 1843, there has passed already over it a *nett* tonnage of	500,000
Besides which there has passed, in descending and ascending cars, and in locomotive weight, a further tonnage in these five years, of *at least*	500,000
Total,	1,000,000

making a gross tonnage of at least one million which has rolled over this Reading road in the past five years, thus affording in itself proof positive

that it can *more than* survive one year's business of the Schuylkill canal; its rail being still as good as new.

As to the second assertion, it is only of use, after this, to notice it with the view of holding up the enormities, of which Mr. Ellet is capable, towards a railway. Thus at 75 cents per ton on 800,000 tons, the wear would be equal to $600,000, and at $55 per ton to near 11,000 tons of iron *consumed per annum;* while the *whole track* does not contain much over 7,500 tons. At this rate it would not be possible to supply a new track as fast as the old was destroyed, not even were *saw and rolling mills* to be provided alternately with the water stations on its whole line. But with the help of my present expose, I may fairly trust it to the common sense of the reader to see that no such condition of things could ever happen.

Let me, however, look a little more particularly into this matter of the wear of the rail, and by reverting to the data given by Mr. Vignoles, assist the reader to understand it. The Stockton and Darlington does a large coal business of 700,000 to 800,000 tons per annum, besides 10 to 12 passenger trains daily, and the Liverpool and Manchester does also an immense business. The wear on both these roads is stated by him to be about one-tenth of a pound per yard per annum; each yard weighing say 60 pounds; the wear would then amount on a double track of 4 rails to four-tenths of a pound per yard, equal to 704 pounds of iron per mile, or for 94 miles 66,176 pounds; say 30 tons annually, and at $55 per ton, makes only $1,650 per annum, for the cost, on this data, from *mere abrasion* of rails. There will always be defective rails on a long line of railway, which will display themselves at intervals for several years, by exfoliation, until they are all expelled, and which may be estimated as about equal in cost to the abrasion. The road once freed from these imperfect rails, but little trouble is afterwards experienced; and the whole expense for renewals, less value of the crushed material, worth say two-thirds of the new will not then much exceed, say $30 to $35 per mile of road per annum; which will cover a very long period before the whole first cost of the iron is thus expended; and in the mean time this will no doubt be rendered the easier by the rails being, ere long, produced in the Schuylkill valley, on the very line of the road itself, the expense being then only the cost of re-rolling the rail and a small loss of weight—making it at least as cheap as they have ever been imported free of duty.

The fragility of the rail, therefore, is but a poor dependance on which to rely for getting rid of the competition of a railway, and so far from this being likely to be diminished hereafter, in the case of the Reading railway, its proprietors have lately determined on completing forthwith the double track with a 60 pound rail, and otherwise in wharves and additional cars, increasing its facilities for accommodating the coal business in particular, for which it was mainly constructed. The canal proprietors on the Schuylkill and the Lehigh are also said to be preparing themselves for the most determined resistance, so that coal, already reduced by this contest from six to three dol-

lars per ton, is not likely to rise soon, if it do not fall to a still lower mark. The dividends of the railway may in consequence be somewhat impaired for the moment, by this and other competition, but it will *always* be there as the *main regulator* of the coal trade, and until this is *acknowledged*, no permanent and just standard of charge, either by railway or canal, can be arrived at, by which all may at least, more or less, live and prosper. This is irrisistible so long as in the plan of the present *lateral car and boat* required on the canal, the railway *supplies a car* as a substitute for the two first, and carries the same to a cheaper and more convenient point of delivery than is done by the boat. The continuance of low prices for coal in the next five years, must have the good effect of at least doubling the present annual consumption, estimated to be 1,200,000 tons of anthracite alone.

From some cause, Mr. Ellet would seem to have bound himself to *force a conclusion* that railways are yet of very limited capacity, and particularly unfit for the profitable carriage of *heavy* freight, as well because they would soon break down under it, as that they cannot afford to carry it as cheaply as its *small value* generally requires, which faculty, he would persuade us, and for hardly a better reason, however, than *old custom*, belongs only to canals; and with a Chinese reverence in this respect, opposes through thick and thin all innovation upon it. There was a time when this position had some slight color of support, but the ruthless progress of the age has overturned it, and now in the generality of cases, in this country particularly, it may be safely assumed that hereafter the railway will have the preference over the canal, even though its main object be that of *heavy* freight, in the *sound* of which, as before explained, there is far more terror than in its carriage. In the instance of the Reading railway, now so noxious in certain quarters, there is a peculiar adaptedness to this *heavy* business, there being here a union of steam power and gravity, with an unbroken connection in its terminations for the coal business, and what must give it an easy triumph over its rivals, the canals, in so far as becoming ultimately the GREAT REGULATOR of this trade.

If I have now *railed* too long at Mr. Ellet, I must plead in excuse the nature of the subject, and the very great importance of having it rightly understood by the public. Even in the great State of New York, against the experience around about them, this exploded doctrine of the cheaper character of canals is maintained—or pretended to be so—taking care, however, to *fetter* the railways which run parallel to their great Erie canal; this was a great project in its day, but its enlargement afterwards could only be effected by a constant and diligent circulation of the same erroneous views in respect to railways, which at this late day I find Mr. Ellet so zealous to keep alive. Ten millions have already been wasted in this enlargement, and fifteen millions of dollars more would be required to complete it, for which there are yet advocates, while two-thirds of this last sum would suffice not only to prepare the line of railways between Buffalo and Albany to do the whole business of the canal, but would suffice to carry the line down to

Goshen, and from thence, by railways already made, connect Buffalo and New York. The opponents of a railway to Albany always refer to the competition of the steamboats on the Hudson, as insurmountable. Now by steamboat the *through* traveller can only be delivered either way between Albany and New York *at a loss of the whole day and part of the next, besides the expenses of laying over*, which may all be estimated at $1 50 to each ordinary traveller, and more to a business one; therefore, if the steamboat carried for *nothing*, this extra expense must be entailed, and would amply pay the railway in summer, and in winter it could have no opposition, being always able to make the trip between these great central business points in five or six hours. On the Erie canal there is now annually taken in tolls *two*—in freight *two and a half*—and in passage money *one* million of dollars, or in all about *five and a half* millions of dollars, between Buffalo and Albany, a distance of 363 miles. Now were the railways on this line allowed so to adjust themselves, as to do this large business, I believe they could do it all, at a good profit, for three millions of dollars, or effecting a saving of the present entire freight, of *two and a half* millions of dollars, with greater accommodation to the immense business on the line of the canal and railroads themselves, by not restricting it to a part of the year only. Any reform of this sort, may do to speculate upon, with little hope now of its being ever effected, the contrary interests having too strong a hold, besides an impenetrable ignorance of the comparative merits of these improvements generally, which cannot be suddenly dispelled. Both these obstacles, in the community which it most benefits, have done their worst to frustrate the Reading railway, but it has now attained a safe position, and at an outlay of say eight millions of dollars, will, in its way, represent the most formidable engine of transportation in the *world*. A vast dependant population, on the anthracite coal fields of Pennsylvania, should be ever grateful to it, for having freed them entirely from the monopolizing gripe of the canals, and with the all pervading economy of which the railway system is the source, to the *poor man* in particular, we should all be eager to lend it a pushing hand, rather than imitate Mr. Ellet in underrating its capacity and its usefulness. F.

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NOTES ON PRACTICAL ENGINEERING.—NO. 5.

Bridges.

The suspension bridge of wire across the Schuylkill, at Philadelphia, Mr. C. Ellet, Jr., engineer, offers an admirable illustration of a position assumed in the last number: that the employment of engineers of education and experience to project a structure suitable to the locality, and adapted to its objects, would be attended with vast benefit to all interested; the community as well as the proprietors. The patentee of some particular mode of construction recommends his plan in all situations, and, to take the most favorable view of the case, let us suppose a bridge on Howe's plan, the best

patented American bridge, to occupy the place of the suspension bridge at Fairmount. It is unnecessary to draw any comparisons—the statement of the case is more than sufficient.

The cost of the wire bridge is said to have been under $60,000: less than half the cost of the wooden bridge, which was burnt down; but, never having seen any other than newspaper reports, I am unable to offer any remarks on the subject, beyond stating that a saving in first cost and subsequent annual expenses will generally result from the employment of competent men. Besides this, I hold that neatness of appearance, and some little degree of harmony with surrounding objects, should not be neglected: indeed, I believe that these will—in the generality of cases—follow, to some extent, a judiciously projected bridge, without in any way increasing the cost.

Every traveller must have noticed the deplorable structures on which he often enters a beautiful village, and which, not unfrequently, disfigures its most populous thoroughfares. Here is an immense amount of employment which the profession should secure to itself, and which in other countries forms no small part of the business of the engineer. In this country, however, where bridges are more required than in any other, and where limited means strongly indicate the propriety of ascertaining the capability and cost of different plans, all is left to chance, and in place of adorning, the bridge is only too often the only drawback on the scene. For example, the lattice bridge across the Hudson, at the city of Troy, is in many positions of the spectator a complete "blur," in a view otherwise rather interesting. Numerous instances will suggest themselves to the reader, and I will only observe, that any engineer who will take the trouble to study any particular site for a bridge—be the span only 40 or 50 feet—will almost invariably strike out some particular plan, which, in his opinion, is superior to all the others he has considered; taking into consideration the nature of the traffic, the amount appropriated, the quality of the timber and stone and the surrounding scenery. Without exactly regarding this as the best possible plan, it will, in nine cases out of ten, be superior to the off-hand suggestions of an engineer of far greater pretensions.

The numerous bridges on the enlarged portion of the Erie canal offered numerous opportunities for improvement in these structures, and the experience acquired on that work had abundantly demonstrated the want of more efficient and lasting bridges. It is impossible to conceive anything more incongruous than the new bridges generally. The abutments are beautifully constructed of cut lime-stone, and are surmounted by a lattice bridge boarded and shingled. The abutments are not only permanent but costly, conveying no idea of limited means or even economy; the bridge itself is unsightly, perishable and combustible, and together they form a capital specimen of the "shabby-genteel" in engineering. Taking the cost of abutments and superstructure together, we should have had a sum sufficient to have adorned the route of the canal with a great variety of bridges, superior to the present structures in durability, economy of repairs and appearance, if in the hands

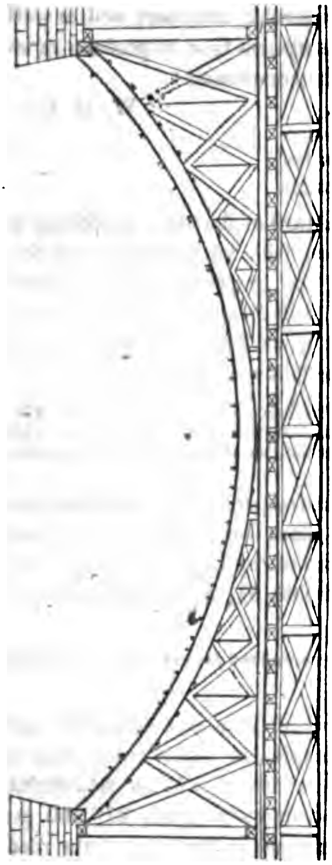
of competent persons; the Schuylkill bridge, already referred to, will sufficiently explain my meaning. With the exception of the bridge at Utica, designed by Mr. Whipple, engineer, I do not know of any attempt to introduce a bridge substantially new or differing from those in ordinary use.

Mr. Wipple's bridge consists of a flat cast iron polygonal arch, from which the roadway is suspended by vertical wrought iron rods, stiffened vertically by similar rods crossing each other and acting as struts as well as ties from their shortness. The strings or tie-beams are replaced by iron rods, so that the floor beams and the plank are the only perishable parts. The details are very neatly arranged, the bridge is remarkably stiff and may be easily rendered, practically speaking, fire-proof. Still the effect is not what it might be. A circular or elliptical arch would have looked better, and being of cast iron, a reasonable degree of ornament would not have added to the cost. But this might have prevented its adoption "in toto" by the canal commissioners, who, reckless of expenditure, have a most democratic dread of any design which can, from any cause—even simple beauty of proportion—give pleasure to, or elevate the feelings of, the beholder. This principle has been carried out to some extent on the Croton water-works. For example, the great arch at Sing Sing, built of granite in the best manner and at great cost, shows how much may be done towards reducing the architectural effect of a structure where the magnitude of the span, the nature of the material and the surrounding scenery conspire to produce a work which should do honor to the nation and to the profession, a praise which all must accord to the "distributing reservoir," though built mainly of rubble masonry, and of the simplest form.

The distinguishing characteristic of English bridges is that the timbers are all, or nearly all, subjected to compression; American bridges depending generally on a string or tie-beam. Now, where it is difficult to keep the grade high enough to clear floods, the English plan of placing arches beneath the roadway becomes impracticable, though I still think that there is vast room for improvement here, not excepting Mr. Howe's very creditable arrangement of braces, iron rods and abutting blocks.

It is common in Europe to pave wooden bridges, and I believe the bridge in the city of Providence was paved, and found to answer well. Where the traffic is great, the plank wear out fast, and a thin coating of loose gravel is very injurious, by admitting moisture and heat to the plank and preventing evaporation. If the plank be covered, the materials should be put on in sufficient quantity to prevent the percolation of the water. On railway bridges where the roadway is not subjected to the action of wheels and horses' hoofs, a thick coating of gravel and tar does very well. Where the frame work of a bridge is not covered in, it is a good plan to put on two or three coats of paint and sand which serves as a protection in some degree against fire as well as against the weather. I look forward with much interest to the results of Kyan's, Earle's and Payne's process for preserving timber, and it

certainly appears that sufficient time has elapsed to test their value in some degree.



The bridge represented in the wood cut was designed in the autumn of 1841, and built during the following winter, to replace a lattice bridge destroyed by fire. The span is 70 feet, the rise 15 feet, outside width 20 feet. There are 4 arches 12 by 20 inches, formed of 10 two inch planks, planed, covered with vegetable tar, and bolted together with 2 three-fourths inch bolts every 4 feet. The vertical rods are of one and one-fourth inch iron, and the arches and floor are braced horizontally in the usual manner. The arrangement of the floor timbers is not good, but I was compelled to suit the design to certain dimensions of material on hand.

For engines, exceeding 7 to 8 tones in weight, the arches should be 24 inches deep, and with the most suitable dimensions of longitudinal and floor timbers, 3 arches would be sufficient for 10 or 12 ton engines. It will be seen at a glance that the great difficulty is to give sufficient stiffness in the centre. The object was to guard against fire, and the arches and strings were to have been covered with sheet iron. They were, however, protected by three coats of paint and sand, and with the heavy covering of clay and gravel on the floor, the bridge is tolerably safe from the incendiary—a more formidable, and perhaps more frequent enemy than the sparks from the engine.

Arches built in this manner have a strong tendency to retain their form. During the erection of the above bridge a sudden rise in the river disturbed the centering and forced the arches back at the springing, increasing the span as it were, but on restoring the centering to its position the arches sprung back to their original form with great violence. Though built in the plainest manner and of trifling span, the effect is greater than can well be believed without inspection. The use of plank arches is of old date in this country for suspending the road way, and there are fine specimens of large arches of plank under the roadway in Weale's bridges. The arrangement of the spandrels is however different, and I believe the arches described above were put together in a more substantial manner; no wooden pins were used, the plank were only ten inches thick and well planed and firmly bolted together without felt.

This bridge has little or no thrust, is far superior in appearance to any wooden bridge I have seen, admits of considerable ornament and is well adapted to sites, where civilization has had sufficient time to produce its legitimate effects on the taste and feelings of the community.

New York, January, 1844. W. R. C.

For the American Railroad Journal and Mechanics' Magazine.

FAILURE OF RAILWAYS.

When Mr. Ellet first advanced his unheard of doctrine, proposing to make the cost of railroads and their fixtures, with an eye to the business which they were likely to obtain—urging the propriety of making little roads for little business, and large and strong roads for a heavy trade—a very learned critic assailed the monstrous idea in your Journal of January 1st, 1842. From this valuable paper I copy the following paragraph:

"Still another comparison may be made between the Schuylkill canal, which costs $38,000 per mile without boats, and the Philadelphia and Pottsville railway, which costs $50,000 per mile, including cars and motive power. Is it not this additional cost which makes it the superior and cheaper work of the two?"

It will doubtless be gratifying to your correspondent, to learn that this great railway has augmented its superiority, since that period, to the amount of $26,000 per mile. The present cost of the railway appears, by the company's last report, to be no less than $7,119,295 51, or, in round numbers, $76,000 per mile.

Its great merit was its great cost. *It has increased this merit in the brief space of two years fifty per cent.*

The road is not yet finished, but the company have just obtained a loan of $1,000,000, with which they *hope* to complete it. This sum, added to the interest now unpaid, and the current year's interest, will add $1,500,000 to the present cost of the work, or, in round numbers again, $16,000 per mile. This is equivalent to an additional increase in the merit of the road, for the present year, of 33 per cent. Its merit, accordingly, at the end of this year, will be simply that of having cost $92,000 per mile.

Verily, Mr. Ellet was "behind the age," to use the language of your correspondent, and the Reading railroad company are fast coming up with the age. Y.

We commence the publication, in this number of the Journal, of a very extensive series of tables for calculating quantities of excavation and embankment. These tables will be completed in the next number, and will be followed by a general description of the mode of calculating them as well as a rigorous investigation of the principles on which they are founded. They are prepared for different slopes and bases. The transverse and longitudinal inclinations of the ground are also allowed for

When completed, we shall, if sufficient inducement offer, publish them in pamphlet form, for the convenience of those who may desire to have them

separately, and we believe that they will form a valuable present to the members of the profession, who will also duly estimate the skill and industry of the gentleman by whom they have been calculated and arranged. As it is our intention to make the Journal as useful as possible to the engineer, we cheerfully contribute the additional labor and expenditure incurred on our part, in bringing forward these elaborate tables.

We cheerfully give place to the report of the Schuylkill Navigation Company, exhibiting the result of their operations for the past year. This company has been many years in very successful operation, and its stock was at one time esteemed the most productive in the country, having paid, we believe, for several years about 20 per cent. per annum; of this, however, we are not sure, as this is the first of their reports which has come under our observation. From this report it appears that the company are enlarging the capacity of the canal, to enable them to reduce their tolls still more, and thus retain the coal trade, for which, the Reading railroad has become a competitor. Competition in business, while it often produces general good by the reduction of expenses common to all, the poor as well as the rich, not unfrequently operates disadvantageously to individuals; and such has probably been the case in this instance, as the stockholders in this canal company now receive only six per cent. on their investment instead of 15 or 20 as formerly: but the competition of the railroad has reduced the cost of transportation of coal from Pottsville to Philadelphia full one dollar per ton, thus effecting an annual saving to the consumers of coal in this country, of at least one and a-half millions of dollars a year. It does not, however, follow, that the canal is to lose its business because the railroad obtains a portion of the coal trade—far otherwise—as their competition alone, if no other cause operated, would produce a large increase in the consumption. In 1834 there was 226,692 tons of coal shipped from Pottsville; the past year, 1843, it has exceeded 680,000 tons, or trebled in nine years. Of course there will be a continued increase in the business, which will require both works to extend their means for accommodating it; and our greatest apprehension is, that they will not be able, at present rates of transportation, to keep up the competition and give the shareholders a fair return for their investment; and would say to the managers of both companies, come to a fair price, say $1·40 or $1·50 per ton, and then let your rivalry be which shall get most business at that.

REPORT OF THE SCHUYLKILL NAVIGATION COMPANY TO THE STOCKHOLDERS.

The president and managers of the Schuylkill navigation company, respectfully submit to the stockholders their annual report for the year 1843, which has just ended.

The unusual lateness of the spring prevented the opening of the navigation until the 10th of April; after which it continued uninterrupted and in excellent order until closed, in December, for the winter. The supply of water has been good, rendering unnecessary a resort to the ample stores contained in the reservoirs.

I.—OF THE STATE OF THE WORKS.

The works generally are in good order; and the repairs required this winter are not heavy. Throughout the line of 108 miles, from Port Carbon to Philadelphia, the works are much more substantial than formerly, having been greatly improved and strengthened within the last few years, while the canal banks have attained great solidity by time. The wooden portions of the mechanical structures are the principal causes of expense for repairs.

The new dam recently erected at Fairmount, under the authority and at the expense of the city corporation, to replace the old one, which had stood twenty-two years, and had become very leaky, is an excellent piece of work,

and relieves the company's navigation, for more than five miles, from the injury caused by the defective and sunken condition of the old dam.

That pool has been the most defective part of the line, and has been the cause of more trouble and expense to the boatmen than any other. As the water could not be drawn down to deepen the channel, the construction of coffer dams has been required; and in former years several portions of the pool have been thus improved, so as to give a depth of five and a-half feet when the river is at its ordinary stage. During the past season, shallow places, amounting in the aggregate to the length of 2,288 feet, have been thus deepened; and it is believed that the boatmen will hereafter be able to pass through this pool with the same facility as the rest of the line.

Most of the dams on the lower part of the Schuylkill, where the river is large, have been rebuilt by the company within a few years, in the most substantial manner, and so as to give an increased depth of water. During the past season it has been the policy of the managers to maintain the works in the most efficient state, at as small an expense as the length and importance of the line, and the large amount of mechanical work upon it would permit; and they think that they have succeeded to a gratifying extent—as the great reduction, amounting to $31,064 33, in the annual current expenses for repairs, salaries, and lock-tenders' wages will indicate; which has been effected without impairing the efficiency of the police of the line, or the means for the rapid passage of the boats.

The new outlet lock at the cross-cut, fourteen miles from the head of the works, has been completed this season. The foundation was laid, and the cut stone walls carried above the level of the pool in 1841, when its completion was postponed. This is now accomplished in the best manner, overcoming a lift of twelve feet two inches, which formerly required two locks.

II.—OF THE TRADE OF THE PAST SEASON.

The toll on coal has been retained at the rate of five mills, or half a cent, per ton per mile, at which it was fixed in 1842; and the tolls on most other articles at the former rates of three and four mills per 1,000 pounds per mile —although some have been transferred from the higher to the lower class. The highest class at the rate of six mills, which contained but a small amount of tonnage, has been abolished, and the articles placed in the other classes, so as to simplify the classification. A uniform toll of two cents per mile has been charged on all empty boats, but no toll on any boat when the cargo which it carried paid a toll of five dollars or upwards.

The total tonnage of articles *ascending* the river, exceeds that of 1842 by ten per cent., in which there is a small increase of grain, salt, lumber and iron.

The total tonnage of miscellaneous articles *descending* the river, excluding coal, lime and lime stone, exceeds that of last year by thirteen per cent., having increased from 46,392 to 52,425 tons. This increase is mainly in grain, flour, iron and nails. In lime and lime stone descending, there has been a falling off of 15,328 tons, which is owing to a temporary fluctuation in the general amount of the trade in those articles.

The quantity of coal brought down this season is 447,058 tons—which is nine per cent. less than the trade of last year. This diminution has been caused by diverting a portion of the Schuylkill coal trade from the natural channel of the navigation, and forcing it upon the Reading railroad; which has been effected to some extent by those having the control of that work, by means of a scale of prices far below what is known upon any other railroad, and which has been repeatedly varied and reduced, for the apparent purpose of diverting the coal trade from the canal.

Notwithstanding this extraordinary competition, the pecuniary results of this year's business have been highly gratifying, and they may be briefly stated as follows:

Amount of tolls received in 1843,	$260,724 38	Current expenses for repairs, salaries and lock tenders' wages,	$71,856 67
" Rents "	19,070 25	Expenses completing new lock at cross-cut,	5,093 08
Receipts,	$279,794 63	Interest account,	100,623 78
Deduct expenses and interest,	177,573 46		
Surplus,	102,221 17	Expenses and interest,	177,573 46

Leaving a surplus of $102,221 17 from the business of 1843, after paying expenses and interest, and completing the new lock; which is more than six per cent. upon the capital stock of the company.

The reduction of tolls upon the Union canal has increased the tonnage derived from that source.

The income received from rents is $19,070 25, being $2,070 25 more than the estimate given in the last annual report; and the company possesses a large amount of valuable water power, still undisposed of.

The whole number of Schuylkill canal boats in use in 1843, has been about 800—of which 770 have been registered as passing the Fairmount locks. Of these, 278 are covered boats, adapted to the direct trade from Pottsville to New York: 434 are open coal boats, and 58 lime boats and miscellaneous.

The direct trade to New York amounts this year to 119,972 tons, taken through the Delaware and Raritan canal, consisting of 2,045 boat loads—averaging 58 tons 13 cwt. each.

III.—OF THE FINANCES OF THE COMPANY.

The present amount of the loans of the company is $1,791,020 19; and the annual interest accruing upon them, $96,533 70. Of the $300,000 loan of 1837, $120,000 have been paid off in the past year, and the residue extended until the first of January, 1854.

It has been the fortune of this great work, from its commencement to the present time, to meet occasionally with obstructions and difficulties, calling for patient fortitude on the part of the stockholders.

During the last two years, the state of the trade, the general prostration of credit and confidence, together with an extraordinary competition, occurring at a period when loans were falling due, which under ordinary circumstances could have been easily renewed, have obliged the board to apply the revenue of the company, diminished by the reduction of the toll, to the payment of debt; and thus the two years have necessarily passed without a dividend, though the income afforded an annual surplus of more than six per cent. There could be no hesitation about the obligation so to apply the revenue. The debt due was a demand of justice, to be paid to the utmost extent of the company's means. The stockholders have borne this privation with their usual firmness; and the profits which have been disbursed by the company, since the 1st of January, 1841, besides paying all current charges and interest, and $105,089 71 for new work, damages and real estate, have reduced the permanent debt of the company $321,156 03, and the annual interest $17,262 30.

Thus in 1841, the permanent debt was - - - - - - -	$2,112,176 22
Now it is only - - - - - - - - - -	1,791,020 19
Difference, - - - - - - - - - -	$321,156 03
In Sept'r and Dec'r, 1841, the interest payable was equal to per annum,	$113,796 00
Now it is - - - - - - - - - -	96,533 70
Difference, - - - - - - - - - -	$17,262 30

Each share of stock has therefore been relieved from a debt to the amount of $9 64, and is intrinsically worth $9 64 more than it would have been if such payment had not been made; and the saving in the annual interest is equal to more than one per cent. per annum upon the whole capital stock.

By reducing, at the same time, the current expenses, these two items, (interest and expenses,) formerly amounting to $224,596 a year, are now, when the accounts are similarly stated, but $172,480.

If the revenue of the year 1844 should be equal to that of 1843, and the same system be pursued, there will be a further reduction of the permanent debt, so that the capital stock and debt will be made nearly equal, and will amount together to about $3,350,000, and the annual interest will be further reduced. Whether or not this course will be the most expedient, must depend upon future circumstances. If it should not, still there will be an annual appropriation to a sinking fund, for the payment of the debt, sufficient to extinguish the whole of it in a reasonable time—an end which ought steadily to be kept in view.

A loan of $153,887 19, at six per cent., will become due on the 1st day of December, 1844; and a loan of $141,100, at five per cent., on the 1st of January, 1845; and an ordinance has been prepared, and will be submitted to the stockholders, to give to the board of managers the necessary power to provide for these loans.

IV.—OF THE CAPACITY OF THE NAVIGATION.

The total tonnage transported upon the Schuylkill navigation since it was first opened for public use, is nearly equal to eight millions of tons; and the line has been in better working order during the past season than ever before. The waters of the river, which nature constantly renews, do not perish in the using, like artificial roads.

In the year 1841, in 29 weeks, the canal carried 737,517 tons, which for the usual season of 35 weeks, would be equal to 890,106 tons. And this is far below the capacity of the existing navigation, the present practical limit of which may be estimated at about a million and a half of tons descending and which may easily be much increased.

The work is a public highway; the boats upon it belong to individuals; and any one, on paying very moderate tolls, and conforming to a few simple regulations, is entitled to use it, all times, and in such way as may best suit his convenience. This has made it of great importance to the counties through which it passes, and to the people who live along its borders, who have found in the canal a most valuable home market for their produce. At the same time, it has left the company without the power of regulating the rates of freight, although they have largely exercised their right of reducing the tolls. For several years after the canal was opened, the load of a canal boat was about 25 tons, and the time required for a trip from Pottsville to Philadelphia, and back, was about two weeks.

A large part of the boats now carry 60 tons; and the trip is often made in eight days. The increasing of the loads, and the shortening of the time, are both important elements in reducing the expense of transportation. The former is mainly due to the increased depth of water, and the latter to the doubling of the locks, and the improvement of the towing paths. Considerable improvements have also been made in the construction of the boats.

The load which a boat can carry being equal to the difference between the weight of the boat and the weight of the water which it displaces when loaded, the lightest boat, other things being equal, can carry the largest load. Many persons interested in the coal trade, having expressed a strong desire that a boat adapted to the Schuylkill navigation should be built of iron, sev-

eral stockholders subscribed to the fund for the purpose of building such an iron boat, which has been done by I. P. Morris & Co., of this city; and the boat, which is of good model and very substantial, has made a successful trip to the coal region and back; but as she has proved to be but little lighter than a good wooden boat of similar dimensions, her tonnage is not materially more.

(To be continued.)

Manumotive Railway Carriage.—We are informed that a machine of this description is in use upon the London and Croydon railway, having been lately made for Mr. Gregory, the resident engineer, by Mr. George England, engineer, well known as the inventor of the patent traversing screw jack, and other important improvements. The machine is light and elegant in appearance, and will carry seven or eight persons at the rate of eighteen miles an hour. It was propelled on Monday week by Mr. Roberts, deputy chairman of the Croydon company, and Mr. England, the inventor, from the New Cross Station to the Dartmouth Arms—a distance of three miles up an inclined plane of 1 in 100, in seventeen minutes, and upon the level line at the rate of twenty miles an hour. It is intended to be used by Gregory and his assistants to traverse the line, inspecting any repairs or other works going on connected with the railway; and will, in our opinion, be found particularly useful for this purpose, and more especially so in connection with those works upon the line which it is necessary to carry on during the night. We have no doubt that these machines will come into general use, as they will effect a considerable saving to the company in the expense of running an engine for the purposes which they will supply. We hail with pleasure anything calculated to reduce that most important item in railway accounts—the locomotive expenses.—[Railway Times.]

Stuffing Boxes.—A great economy in the tallow usually required for stuffing boxes is effected by encircling the rod by a piece of sheet brass, the joint being a diagonal one, and the bottom edge turned up all round like the brim of a hat. This brass tube is packed with hemp at the back, and extends from the bottom of the stuffing box to within three quarters of an inch oft he top, so as to admit of the gland being tightened, and the upper edge of the tube is bevelled off, so as to prevent the packing from catching upon it. This improvement is due to the engineer of the Tagus, in which vessel it has been in successful operation for many months past; its effect is to keep the piston rods in the best possible condition, and to effect a saving of three-fourths of the tallow.—[Artizan.]

English Locomotives on the Continent.—In Germany, says a Leipzig paper, exclusive of Austria, there are 180 locomotives of English manufacture running. Of these, Messrs. Robert Stephenson & Co. made 81, which are distributed over 14 lines of railway; Sharp & Co. made 49 which are running on 10 lines; Turner & Co. made 11; Rothwell, 10; Langridge & Co., 5; Forrester & Co., 5; Kirtly, 5; Tayleur & Co., 1; Bury & Co., 4; Fenton & Co., 2; Gaskell, 2; Rennie, 1; Hawthorn, 1; Total 180.

Helix Propeller.—Some account was lately given to the Paris Academy of Sciences of experiments made with a helix propeller on the Napoleon steamboat. The engines were of 120 horse power, and the results were that she would go 10 knots an hour by steam alone in calm weather, and that in a voyage from Havre to Cherbourg, and from Cherbourg to Southampton, against a strong north wind and heavy sea, she went, with her lofty mast, from 8·7 to 9 knots an hour. Under the same circumstances, the reporter alleges that ordinary paddles would not have exceeded 5 to 6 knots. With the assistance of the wind she went 12 1-2 and 13 knots in the sea. The reporter also affirms, that this vessel, the Napoleon, beat the Pluto, fitted with the Archimedean screw, half a knot an hour; and that the Pluto beat the Archimedean nearly a knot an hour. Of course therefore, this Napoleon would beat the Archimedean 1 1-2 knots an hour.—[Herapath's Journal.]

Profitable Patent.—The *Mining Journal* remarks that it is a curious fact in scientific discovery, that the most profitable invention that was ever patented in this or any other country accidentally arose out of an application to Government to admit sugar for Agricultural purposes. The government applied to Mr. Howard, the accomplished chemist, brother to the late duke of Norfolk, to try some experiments for the purpose of ascertaining if sugar could be so effectually adulterated that it could not be again converted into culinary uses. For this purpose he mixed all kinds of noxious materials with it, but the question remained whether they could be again separated, and in the experiments to ascertain this, he discovered that not only could they be separated, but the sugar was better and purer. Out of this arose Howard's patent for sugar refining and the use of the vacuum pan; the annual nett income of which, from licences granted for its use, at the rate of 1s. per cwt., yielding in some years between £20,000 and £30,000. One house in London alone paid £4,000 per annum.

TABLE No. 1.

SLOPE ½ TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 15 FEET.

Feet.	·0 c. yds.	·1 c. yds.	·2 c. yds.	·3 c. yds.	·4 c. yds.	·5 c. yds.	·6 c. yds.	·7 c. yds.	·8 c. yds.	·9 c. yds.
0	0	6	11	17	23	28	34	40	46	51
1	57	63	69	75	81	87	95	100	106	112
2	119	125	131	138	144	150	157	163	170	177
3	183	190	197	203	210	217	224	231	238	245
4	252	259	266	273	280	287	295	302	309	317
5	324	331	339	346	354	362	369	377	385	392
6	400	408	416	423	431	439	447	455	463	471
7	480	488	496	504	512	521	529	538	546	554
8	563	571	580	589	597	606	615	623	632	641
9	650	659	668	677	686	695	704	713	722	731
10	741	750	759	769	777	786	796	806	816	826
11	835	845	854	864	874	8[illegible]4	894	903	913	923
12	933	943	953	963	974	984	994	1,004	1,014	1,025
13	1,035	1,046	1,056	1,066	1,077	1,087	1,098	1,109	1,119	1,130
14	1,141	1,151	1,162	1,173	1,184	1,195	1,206	1,217	1,228	1,239
15	1,250	1,261	1,272	1,283	1,295	1,306	1,317	1,329	1,340	1,351
16	1,363	1,374	1,386	1,398	1,409	1,421	1,432	1,444	1,456	1,468
17	1,480	1,491	1,503	1,515	1,527	1,539	1,551	1,563	1,576	1,588
18	1,600	1,612	1,624	1,637	1,649	1,662	1,674	1,686	1,699	1,711
19	1,724	1,737	1,749	1,762	1,775	1,787	1,800	1,813	1,826	1,839
20	1,852	1,865	1,878	1,891	1,904	1,917	1,930	1,943	1,957	1,970
21	1,983	1,997	2,010	2,023	2,037	2,050	2,064	2,078	2,091	2,105
22	2,118	2,132	2,146	2,160	2,174	2,187	2,201	2,215	2,229	2,243
23	2,257	2,271	2,286	2,300	2,314	2,328	2,342	2,357	2,371	2,386
24	2,400	2,414	2,429	2,443	2,458	2,473	2,487	2,502	2,517	2,531
25	2,546	2,561	2,576	2,591	2,606	2,621	2,636	2,651	2,666	2,681
26	2,696	2,711	2,727	2,742	2,757	2,773	2,788	2,803	2,819	2,834
27	2,850	2,866	2,881	2,897	2,912	2,928	2,944	2,960	2,976	2,991
28	3,007	3,023	3,039	3,055	3,071	3,087	3,103	3,120	3,136	3,152
29	3,168	3,185	3,201	3,217	3,234	3,250	3,267	3,283	3,300	3,317
30	3,333	3,350	3,367	3,383	3,400	3,417	3,434	3,451	3,468	3,485
31	3,502	3,519	3,536	3,553	3,570	3,587	3,605	3,622	3,639	3,657
32	3,674	3,691	3,709	3,726	3,744	3,762	3,779	3,797	3,814	3,832
33	3,850	3,868	3,886	3,903	3,921	3,939	3,957	3,975	3,993	4,011
34	4,029	4,048	4,066	4,084	4,102	4,121	4,139	4,157	4,176	4,194
35	4,213	4,231	4,250	4,269	4,287	4,306	4,325	4,343	4,362	4,381
36	4,400	4,419	4,438	4,457	4,476	4,495	4,514	4,533	4,552	4,571
37	4,591	4,610	4,629	4,649	4,668	4,687	4,707	4,726	4,746	4,766
38	4,785	4,805	4,824	4,844	4,864	4,884	4,904	4,923	4,943	4,963
39	4,983	5,003	5,023	5,043	5,064	5,084	5,104	5,124	5,144	5,165
40	5,185	5,205	5,226	5,246	5,267	5,287	5,308	5,329	5,349	5,370
41	5,391	5,411	5,432	5,453	5,474	5,495	5,516	5,537	5,558	5,579
42	5,600	5,621	5,642	5,663	5,685	5,706	5,727	5,749	5,770	5,791
43	5,813	5,834	5,856	5,878	5,899	5,921	5,942	5,964	5,986	6,009
44	6,030	6,051	6,073	6,095	6,117	6,139	6,161	6,183	6,206	6,228
45	6,250	6,272	6,294	6,317	6,339	6,361	6,384	6,406	6,429	6,451
46	6,474	6,497	6,519	6,542	6,565	6,587	6,610	6,633	6,656	6,679
47	6,702	6,725	6,748	6,771	6,794	6,817	6,840	6,863	6,887	6,910
48	6,933	6,957	6,980	7,003	7,027	7,050	7,074	7,098	7,121	7,145
49	7,168	7,192	7,216	7,240	7,264	7,287	7,311	7,335	7,359	7,383
50	7,407	7,431	7,456	7,480	7,504	7,528	7,552	7,577	7,601	7,625
51	7,650	7,674	7,699	7,723	7,748	7,773	7,797	7,822	7,847	7,871
52	7,896	7,921	7,946	7,971	7,996	8,021	8,046	8,071	8,096	8,121
53	8,146	8,171	8,197	8,222	8,247	8,273	8,298	8,324	8,349	8,374
54	8,400	8,426	8,451	8,477	8,502	8,528	8,554	8,580	8,606	8,631
55	8,657	8,683	8,709	8,735	8,761	8,787	8,814	8,840	8,866	8,892
56	8,918	8,945	8,971	8,997	9,024	9,050	9,077	9,103	9,130	9,157
57	9,183	9,210	9,237	9,263	9,290	9,317	9,344	9,371	9,398	9,425
58	9,452	9,479	9,506	9,533	9,560	9,587	9,615	9,642	9,669	9,69
59	9,724	9,751	9,779	9,806	9,834	9,862	9,889	9,917	9,944	9,972
60	10,000	10,028	10,056	10,083	10,111	10,139	10,167	10,195	10,223	10,251

TABLE No. II.

SLOPE ½ TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 18 FEET.

Feet.	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.
0	0	7	13	20	27	34	41	48	55	61
1	69	76	83	90	97	104	111	119	126	133
2	141	148	156	163	171	178	186	193	201	209
3	217	224	232	240	248	256	264	272	280	288
4	296	304	312	321	329	337	346	354	363	371
5	380	388	397	405	414	423	431	440	449	458
6	467	476	485	493	503	512	521	530	539	548
7	557	567	576	585	595	604	614	623	633	642
8	652	661	671	681	691	700	710	720	730	740
9	750	760	770	780	790	800	811	821	831	841
10	852	862	873	883	894	904	915	925	936	947
11	957	968	979	990	1,001	1,012	1,023	1,034	1,045	1,056
12	1,067	1,078	1,089	1,100	1,111	1,123	1,134	1,145	1,156	1,168
13	1,180	1,191	1,203	1,214	1,226	1,237	1,249	1,261	1,273	1,284
14	1,296	1,308	1,320	1,332	1,344	1,356	1,368	1,380	1,392	1,404
15	1,417	1,429	1,441	1,453	1,466	1,478	1,491	1,503	1,516	1,528
16	1,541	1,553	1,566	1,579	1,591	1,604	1,617	1,630	1,643	1,656
17	1,669	1,681	1,695	1,708	1,721	1,734	1,747	1,760	1,773	1,787
18	1,800	1,813	1,827	1,841	1,854	1,867	1,881	1,894	1,908	1,921
19	1,935	1,924	1,963	1,976	1,990	2,004	2,018	2,032	2,046	2,060
20	2,074	2,088	2,102	2,116	2,131	2,145	2,159	2,173	2,188	2,202
21	2,217	2,231	2,246	2,260	2,275	2,289	2,304	2,319	2,333	2,348
22	2,363	2,378	2,393	2,408	2,423	2,437	2,453	2,468	2,483	2,498
23	2,513	2,528	2,543	2,559	2,574	2,589	2,605	2,620	2,636	2,651
24	2,667	2,682	2,698	2,713	2,729	2,745	2,761	2,776	2,792	2,808
25	2,824	2,840	2,856	2,872	2,888	2,904	2,920	2,936	2,952	2,969
26	2,985	3,001	3,018	3,034	3,051	3,067	3,084	3,100	3,117	3,133
27	3,150	3,167	3,183	3,200	3,217	3,234	3,251	3,268	3,285	3,301
28	3,319	3,336	3,353	3,370	3,387	3,404	3,421	3,439	3,456	3,473
29	3,491	3,508	3,526	3,543	3,561	3,578	3,596	3,613	3,631	3,649
30	3,667	3,684	3,702	3,720	3,738	3,756	3,774	3,792	3,810	3,828
31	3,846	3,864	3,883	3,901	3,919	3,937	3,956	3,974	3,993	4,011
32	4,030	4,048	4,067	4,085	4,104	4,123	4,141	4,160	4,179	4,198
33	4,217	4,236	4,255	4,273	4,293	4,312	4,331	4,350	4,369	4,388
34	4,407	4,427	4,446	4,465	4,485	4,504	4,524	4,543	4,563	4,582
35	4,602	4,621	4,641	4,661	4,681	4,700	4,720	4,740	4,760	4,780
36	4,800	4,820	4,840	4,860	4,880	4,900	4,921	4,941	4,961	4,981
37	5,002	5,022	5,043	5,063	5,084	5,104	5,125	5,145	5,166	5,187
38	5,207	5,228	5,249	5,270	5,291	5,312	5,333	5,353	5,375	5,396
39	5,417	5,438	5,459	5,480	5,501	5,523	5,544	5,565	5,587	5,608
40	5,630	5,651	5,673	5,694	5,716	5,737	5,759	5,781	5,803	5,824
41	5,846	5,868	5,890	5,912	5,934	5,956	5,978	6,000	6,022	6,044
42	6,067	6,089	6,111	6,133	6,156	6,178	6,201	6,223	6,246	6,268
43	6,291	6,313	6,336	6,359	6,381	6,404	6,427	6,450	6,473	6,496
44	6,519	6,541	6,565	6,588	6,611	6,634	6,657	6,680	6,703	6,727
45	6,750	6,773	6,797	6,820	6,844	6,867	6,891	6,914	6,938	6,961
46	6,985	7,009	7,033	7,056	7,080	7,104	7,128	7,152	7,176	7,200
47	7,224	7,248	7,272	7,296	7,321	7,345	7,369	7,393	7,418	7,442
48	7,467	7,491	7,516	7,540	7,565	7,589	7,614	7,639	7,663	7,688
49	7,712	7,738	7,763	7,788	7,813	7,837	7,863	7,888	7,913	7,938
50	7,963	7,988	8,013	8,039	8,064	8,089	8,115	8,140	8,166	8,191
51	8,217	8,242	8,268	8,293	8,319	8,345	8,371	8,396	8,422	8,448
52	8,474	8,500	8,526	8,552	8,578	8,604	8,630	8,656	8,683	8,709
53	8,735	8,761	8,788	8,814	8,841	8,867	8,894	8,920	8,947	8,973
54	9,000	9,027	9,053	9,080	9,107	9,134	9,161	9,188	9,215	9,241
55	9,269	9,296	9,323	9,350	9,377	9,404	9,431	9,459	9,486	9,513
56	9,541	9,568	9,596	9,623	9,651	9,678	9,706	9,733	9,761	9,789
57	9,817	9,844	9,872	9,899	9,927	9,955	9,984	10,012	10,040	10,068
58	10,096	10,124	10,153	10,181	10,209	10,237	10,266	10,294	10,323	10,351
59	10,380	10,408	10,437	10,465	10,494	10,523	10,551	10,580	10,609	10,638
60	10,667	10,696	10,725	10,753	10,783	10,812	10,841	10,870	10,899	10,928

TABLE No. III.

SLOPE ½ TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 25 FEET.

Feet.	·0 c. yds.	·1 c. yds.	·2 c. yds.	·3 c. yds.	·4 c. yds.	·5 c. yds.	·6 c. yds.	·7 c. yds.	·8 c. yds.	·9 c. yds.
0	0	9	19	28	37	47	56	66	75	85
1	94	104	114	123	133	143	153	163	173	183
2	193	203	213	223	233	243	253	264	274	284
3	294	305	315	326	336	347	357	368	378	389
4	400	411	422	432	443	454	465	476	487	498
5	509	520	532	543	554	565	577	588	599	611
6	622	634	645	657	668	680	692	703	715	727
7	739	751	763	775	787	799	811	823	835	847
8	859	872	884	896	908	921	933	946	958	971
9	983	996	1,008	10,21	1,034	1,047	1,059	1,072	1,085	1,098
10	1,111	1,124	1,137	1,150	1,163	1,176	1,190	1,203	1,216	1,229
11	1,243	1,256	1,269	1,283	1,296	1,310	1,323	1,337	1,350	1,364
12	1,378	1,391	1,405	1,419	1,433	1,447	1,461	1,475	1,489	1,503
13	1,517	1,531	1,545	1,559	1,573	1,587	1,602	1,616	1,630	1,645
14	1,659	1,674	1,688	1,703	1,717	1,732	1,746	17,61	1,776	1,791
15	1,806	1,820	1,835	1,850	1,865	1,880	1,895	1,910	1,925	1,940
16	1,956	1,971	1,986	2,001	2,017	2,032	2,047	2,063	2,078	2,094
17	2,109	2,125	2,140	2,156	2,172	2,187	2,203	2,219	2,235	2,251
18	2,267	2,283	2,299	2,315	2,331	2,347	2,363	2,379	2,395	2,411
19	2,428	2,444	2,460	2,477	2,493	2,510	2,526	2,543	2,559	2,576
20	2,593	2,609	2,626	2,643	2,660	2,676	2,693	2,710	2,727	2,744
21	2,761	2,778	2,795	2,812	2,830	2,847	2,864	2,881	2,899	2,916
22	2,933	2,951	2,968	2,986	3,003	3,021	3,038	3,056	3,074	3,091
23	3,109	3,127	3,145	3,163	3,181	3,199	3,217	3,235	3,253	3,271
24	3,289	3,307	3,325	3,343	3,362	3,380	3,398	3,417	3,435	3,454
25	3,472	3,491	3,509	3,528	3,546	3,565	3,584	3,603	3,622	3,640
26	3,659	3,678	3,697	3,716	3,735	3,754	3,773	3,792	3,812	3,831
27	3,850	3,869	3,889	3,908	3,927	3,947	3,966	3,986	4,005	4,025
28	4,044	4,064	4,084	4,103	4,123	4,143	4,163	4,183	4,203	4,223
29	4,243	4,263	4,283	4,303	4,323	4,343	4,363	4,383	4,404	4,424
30	4,444	4,465	4,485	4,506	4,526	4,547	4,567	4,588	4,608	4,629
31	4,650	4,671	4,692	4,712	4,733	4,754	4,775	4,796	4,817	4,838
32	4,858	4,880	4,902	4,923	4,944	4,965	4,987	5,008	5,029	5,051
33	5,072	5,094	5,115	5,137	5,158	5,180	5,202	5,223	5,245	5,267
34	5,289	5,311	5,333	5,355	5,377	5,399	5,421	5,443	5,465	5,487
35	55,09	5,531	5,554	5,576	5,598	5,621	5,643	5,666	5,688	5,711
36	5,733	5,756	5,778	5,801	5,824	5,847	5,870	5,892	5,915	5,938
37	5,961	5,984	6,007	6,030	6,053	6,076	6,099	6,123	6,146	6,169
38	6,193	6,216	6,239	6,263	6,286	6,310	6,333	6,357	6,380	6,404
39	6,428	6,451	6,475	6,499	6,523	6,547	6,571	6,595	6,619	6,643
40	6,667	6,691	6,715	6,739	6,763	6,787	6,812	6,836	6,860	6,885
41	6,909	6,934	6,958	6,983	7,007	7,032	7,057	7,081	7,106	7,131
42	7,156	7,180	7,205	7,230	7,255	7,280	7,305	7,330	7,355	7,380
43	7,406	7,431	7,456	7,481	7,507	7,532	7,557	7,583	7,608	7,634
44	7,659	7,685	7,710	7,736	7,762	7,787	7,813	7,839	7,865	7,891
45	7,917	7,943	7,969	7,995	8,021	8,047	8,073	8,099	8,125	8,151
46	8,178	8,204	8,230	8,257	8,283	8,310	8,336	8,363	8,389	8,416
47	8,442	8,469	8,496	8,523	8,550	8,576	8,603	8,630	8,657	8,684
48	8,711	8,738	8,765	8,792	8,820	8,847	8,874	8,901	8,929	8,956
49	8,983	9,011	9,038	9,066	9,093	9,121	9,148	9,176	9,204	9,231
50	9,259	9,287	9,315	9,343	9,371	9,399	9,427	9,455	9,483	9,511
51	9,539	9,567	9,595	9,623	9,652	9,680	9,708	9,737	9,765	9,794
52	9,822	9,851	9,879	9,908	9,936	9,965	9,994	10,023	10,052	10,080
53	10,109	10,138	10,167	10,196	10,225	10,254	10,283	10,312	10,342	10,371
54	10,400	10,429	10,459	10,488	10,517	10,547	10,576	10,606	10,635	10,665
55	10,694	10,724	10,754	10,783	10,813	10,843	10,873	10,903	10,933	10,963
56	10,993	11,023	11,053	11,083	11,113	11,143	11,173	11,203	11,234	11,264
57	11,294	11,325	11,355	11,386	11,416	11,447	11,477	11,508	11,538	11,569
58	11,600	11,631	11,662	11,692	11,723	11,754	11,785	11,816	11,847	11,878
59	11,909	11,940	11,972	12,003	12,034	12,065	12,097	12,128	12,159	12,191
60	12,222	12,254	12,285	12,317	12,348	12,380	12,412	12,443	12,475	12,507

TABLE No. IV.

SLOPE ½ TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 28 FEET.

Feet.	·0 c. yds.	·1 c. yds.	·2 c. yds.	·3 c. yds.	·4 c. yds.	·5 c. yds.	·6 c. yds.	·7 c. yds.	·8 c. yds.	·9 c. yds.
0	0	10	21	31	42	52	63	73	84	95
1	106	116	127	138	149	160	171	182	193	204
2	215	226	237	248	260	271	282	293	305	316
3	328	339	341	352	364	376	387	399	411	423
4	444	456	468	480	492	504	516	528	540	553
5	565	577	589	602	614	626	639	651	654	666
6	689	701	714	727	740	752	765	778	791	804
7	817	830	843	856	869	882	895	908	922	935
8	948	961	975	988	1,002	1,015	1,029	1,042	1,056	1,070
9	1,083	1,097	1,111	1,125	1,138	1,152	1,166	1,180	1,194	1,208
10	1,222	1,236	1,250	1,265	1,279	1,293	1,307	1,322	1,336	1,350
11	1,365	1,379	1,394	1,408	1,423	1,437	1,452	1,467	1,482	1,496
12	1,511	1,526	1,541	1,556	1,571	1,586	1,601	1,616	1,631	1,646
13	1,661	1,676	1,692	1,707	1,722	1,737	1,753	1,768	1,784	1,799
14	1,815	1,830	1,846	1,862	1,877	1,893	1,909	1,925	1,940	1,956
15	1,972	1,988	2,004	2,020	2,036	2,052	2,068	2,085	2,101	2,117
16	2,133	2,150	2,166	2,182	2,199	2,215	2,232	2,248	2,265	2,281
17	2,298	2,315	2,332	2,348	2,365	2,382	2,399	2,416	2,433	2,450
18	2,467	2,484	2,501	2,518	2,535	2,552	2,570	2,587	2,604	2,621
19	2,639	2,656	2,674	2,691	2,709	2,726	2,744	2,762	2,779	2,797
20	2,815	2,833	2,850	2,868	2,886	2,904	2,922	2,940	2,958	2,976
21	2,994	3,013	3,031	3,049	3,067	3,086	3,104	3,122	3,141	3,159
22	3,178	3,196	3,215	3,233	3,252	3,271	3,290	3,308	3,327	3,346
23	3,365	3,384	3,403	3,422	3,441	3,460	3,479	3,498	3,517	3,536
24	3,556	3,575	3,594	3,614	3,633	3,652	3,672	3,691	3,711	3,730
25	3,750	3,770	3,789	3,809	3,829	3,849	3,868	3,888	3,908	3,928
26	3,948	3,968	3,988	4,008	4,028	4,049	4,069	4,089	4,109	4,130
27	4,150	4,170	4,191	4,211	4,232	4,252	4,273	4,293	4,314	4,335
28	4,356	4,376	4,397	4,418	4,439	4,460	4,481	4,502	4,523	4,544
29	4,565	4,586	4,607	4,628	4,650	4,671	4,692	4,713	4,735	4,756
30	4,778	4,799	4,821	4,842	4,864	4,886	4,907	4,929	4,951	4,973
31	4,994	5,016	5,038	5,060	5,082	5,104	5,126	5,148	5,170	5,193
32	5,215	5,237	5,259	5,282	5,304	5,326	5,349	5,371	5,394	5,416
33	5,439	5,461	5,484	5,507	5,530	5,552	5,575	5,598	5,621	5,644
34	5,667	5,690	5,713	5,736	5,759	5,782	5,805	5,828	5,852	5,875
35	5,898	5,921	5,945	5,968	5,992	6,015	6,039	6,062	6,086	6,110
36	6,133	6,157	6,181	6,205	6,228	6,252	6,276	6,300	6,324	6,348
37	6,372	6,396	6,420	6,445	6,469	6,493	6,517	6,542	6,566	6,590
38	6,615	6,639	6,664	6,688	6,713	6,737	6,762	6,787	6,812	6,836
39	6,861	6,886	6,911	6,936	6,961	6,986	7,011	7,036	7,061	7,086
40	7,111	7,136	7,162	7,187	7,212	7,237	7,263	7,288	7,314	7,339
41	7,365	7,390	7,416	7,442	7,467	7,493	7,519	7,545	7,570	7,596
42	7,622	7,648	7,674	7,700	7,726	7,752	7,778	7,805	7,831	7,857
43	7,883	7,910	7,936	7,962	7,989	8,015	8,042	8,068	8,095	8,121
44	8,148	8,175	8,202	8,228	8,255	8,282	8,309	8,336	8,363	8,390
45	8,417	8,444	8,471	8,498	8,525	8,552	8,580	8,607	8,634	8,661
46	8,689	8,716	8,744	8,771	8,799	8,826	8,854	8,882	8,909	8,937
47	8,965	8,993	9,020	9,048	9,076	9,104	9,132	9,160	9,188	9,216
48	9,244	9,273	9,301	9,329	9,357	9,386	9,414	9,442	9,471	9,499
49	9,528	9,556	9,585	9,613	9,642	9,671	9,700	9,728	9,757	9,786
50	9,815	9,844	9,873	9,902	9,931	9,960	9,989	10,018	10,047	10,076
51	10,106	10,135	10,164	10,193	10,223	10,252	10,282	10,311	10,341	10,370
52	10,400	10,430	10,459	10,489	10,519	10,549	10,578	10,608	10,638	10,668
53	10,698	10,728	10,758	10,788	10,818	10,849	10,879	10,909	10,939	10,970
54	11,000	11,030	12,061	11,091	11,122	11,152	11,183	11,213	11,244	11,275
55	11,306	11,336	11,367	11,398	11,429	11,460	11,491	11,522	11,553	11,584
56	11,615	11,646	11,677	11,708	11,740	11,771	11,802	11,833	11,865	11,896
57	11,928	11,959	11,991	12,022	12,054	12,086	12,117	12,149	12,181	12,213
58	12,244	12,276	11,308	12,340	12,372	12,404	12,436	12,468	12,500	12,533
59	12,565	12,597	12,629	12,662	12,694	12,726	12,759	12,791	12,824	12,856
60	12,889	12,921	12,954	12,987	13,020	13,052	13,085	13,118	13,151	13,184

TABLE No. V.

SLOPE $\frac{1}{2}$ TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 30 FEET.

Feet.	·0 c. yds.	·1 c. yds.	·2 c. yds.	·3 c. yds.	·4 c. yds.	·5 c. yds.	·6 c. yds.	·7 c. yds.	·8 c. yds.	·9 c. yds.
0	0	11	22	33	45	56	67	79	90	101
1	113	124	136	148	159	171	183	194	206	218
2	230	242	253	265	277	289	301	313	326	338
3	350	362	374	387	399	412	424	436	449	461
4	474	487	499	512	525	537	550	563	576	589
5	602	615	628	641	654	667	680	693	707	720
6	733	747	760	773	787	800	814	828	841	855
7	867	882	896	910	924	937	951	965	979	993
8	1,007	1,021	1,036	1,050	1,064	1,078	1,092	1,107	1,120	1,136
9	1,150	1,164	1,179	1,193	1,208	1,223	1,237	1,252	1,267	1,281
10	1,296	1,311	1,326	1,341	1,356	1,371	1,386	1,401	1,416	1,431
11	1,446	1,461	1,477	1,492	1,507	1,523	1,538	1,553	1,569	1,584
12	1,600	1,616	1,631	1,647	1,662	1,678	1,694	1,710	1,726	1,741
13	1,757	1,773	1,789	1,805	1,821	1,837	1,854	1,870	1,886	1,902
14	1,919	1,935	1,951	1,968	1,984	2,000	2,017	2,033	2,050	2,067
15	2,083	2,100	2,117	2,133	2,150	2,167	2,184	2,201	2,218	2,235
16	2,252	2,269	2,286	2,303	2,320	2,328	2,355	2,372	2,389	2,407
17	2,424	2,441	2,459	2,476	2,494	2,512	2,529	2,547	2,565	2,582
18	2,600	2,618	2,636	2,653	2,671	2,689	2,707	2,725	2,743	2,761
19	2,780	2,798	2,816	2,834	2,853	2,871	2,889	2,908	2,926	2,944
20	2,963	2,981	3,000	3,019	3,037	3,056	3,075	3,093	3,112	3,131
21	3,150	3,169	3,188	3,207	3,226	3,245	3,264	3,283	3,302	3,321
22	3,341	3,360	3,379	3,399	3,418	3,437	3,457	3,476	3,496	3,516
23	3,535	3,555	3,575	3,594	3,614	3,634	3,654	3,673	3,693	3,713
24	3,733	3,753	3,773	3,793	3,814	3,834	3,854	3,874	3,895	3,915
25	3,935	3,956	3,976	3,996	4,017	4,037	4,058	4,079	4,099	4,120
26	4,141	4,161	4,182	4,203	4,224	4,245	4,266	4,287	4,308	4,329
27	4,350	4,371	4,392	4,413	4,435	4,456	4,477	4,499	4,520	4,541
28	4,563	4,584	4,606	4,628	4,649	4,671	4,693	4,714	4,736	4,758
29	4,779	4,801	4,823	4,845	4,867	4,889	4,911	4,933	4,956	4,978
30	5,000	5,022	5,045	5,067	5,089	5,112	5,134	5,156	5,179	5,201
31	5,224	5,247	5,269	5,292	5,315	5,337	5,360	5,383	5,406	5,429
32	5,452	5,475	5,498	5,521	5,544	5,567	5,590	5,613	5,637	5,660
33	5,683	5,707	5,730	5,753	5,777	5,800	5,824	5,848	5,871	5,895
34	5,919	5,942	5,966	5,990	6,014	6,037	6,061	6,085	6,109	6,133
35	6,157	6,181	6,206	6,230	6,254	6,278	6,303	6,327	6,351	6,376
36	6,400	6,424	6,449	6,473	6,498	6,523	6,547	6,572	6,597	6,621
37	6,646	6,671	6,696	6,721	6,746	6,771	6,796	6,821	6,846	6,871
38	6,896	6,921	6.947	6,972	6,997	7,023	7,048	7,073	7,099	7,124
39	7,150	7,176	7,201	7,227	7,252	7,278	7,304	7,330	7,356	7,381
40	7,407	7,433	7,459	7,485	7,511	7,537	7,564	7,590	7,616	7,642
41	7,669	7,695	7,721	7,748	7,774	7,800	7,827	7,853	7,880	7,907
42	7,933	7,960	7,987	8,013	8,040	8,067	8,094	8,121	8,148	8,175
43	8,202	8,229	8,256	8,283	8,310	8,337	8,365	8,392	8,419	8,447
44	8,474	8,501	8,529	8,556	8,584	8,612	8,639	8,667	8,694	8,722
45	8,750	8,778	8,806	8,833	8,861	8,889	8,917	8,945	8,972	9,000
46	9,030	9,058	9,086	9,114	9,143	9,171	9,199	9,228	9,256	9,284
47	9,313	9,341	9,370	9,399	9,427	9,456	9,485	9,514	9,542	9,571
48	9,600	9,629	9,658	9,687	9,716	9,745	9,774	9,803	9,832	9,861
49	9,891	9,920	9,949	9,979	10,008	10,037	10,067	10,096	10,126	10,156
50	10,185	10,215	10,245	10,274	10,304	10,334	10,364	10,393	10,423	10,453
51	10,483	10,513	10,543	10,573	10,604	10,634	10,664	10,694	10,725	10,755
52	10,785	10,816	10,846	10,876	10,907	10,937	10,968	10,999	11,029	11,060
53	11,091	11,121	11,152	11,183	11,214	11,245	11,276	11,307	11,338	11,369
54	11,400	11,431	11,462	11,493	11,525	11,556	11,587	11,619	11,650	11,681
55	11,713	11,744	11,776	11,808	11,839	11,871	11,903	11,934	11,966	11,998
56	12,030	12,061	12,093	12,125	12,157	12,189	12,221	12,253	12,286	12,318
57	12,350	12,382	12,415	12,447	12,479	12,512	12,544	12,576	12,609	12,641
58	12,674	12,707	12,739	12,772	12,805	12,837	12,870	12,903	12,936	12,969
59	13,002	13,035	13,068	13,101	13,134	13,167	13,200	13,233	13,267	13,300
60	13,333	13,367	13,400	13,433	13,467	13,500	13,534	13,568	13,601	13,635

TABLE No. VI.

SLOPE $\frac{1}{2}$ TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 34 FEET.

Feet.	·0 c. yds.	·1 c. yds.	·2 c. yds.	·3 c. yds.	·4 c. yds.	·5 c. yds.	·6 c. yds.	·7 c. yds.	·8 c. yds.	·9 c. yds.
0	0	13	25	38	51	63	76	89	102	115
1	128	141	154	167	180	193	206	219	233	246
2	259	273	286	299	313	326	340	354	377	391
3	394	408	422	436	450	463	477	491	508	519
4	533	547	562	576	590	604	618	633	647	661
5	676	690	705	719	734	749	763	778	793	807
6	822	837	852	867	882	897	912	927	942	957
7	972	987	1,003	1,018	1,033	1,049	1,063	1,078	1,096	1,110
8	1,126	1,142	1,157	1,173	1,188	1,204	1,220	1,236	1,252	1,267
9	1,283	1,299	1,315	1,331	1,347	1,363	1,380	1,396	1,412	1,428
10	1,444	1,461	1,477	1,494	1,510	1,526	1,543	1,559	1,576	1,593
11	1,609	1,626	1,643	1,659	1,676	1,693	1,710	1,727	1,744	1,761
12	1,778	1,795	1,812	1,829	1,846	1,863	1,881	1,898	1,915	1,933
13	1,950	1,967	1,985	2,002	2,020	2,038	2,055	2,073	2,090	2,108
14	2,126	2,144	2,162	2,179	2,197	2,215	2,233	2,251	2,269	2,287
15	2,306	2,324	2,342	2,360	2,378	2,397	2,415	2,434	2,452	2,470
16	2,489	2,507	2,526	2,545	2,563	2,582	2,601	2,619	2,638	2,657
17	2,676	2,695	2,714	2,733	2,752	2,771	2,790	2,809	2,828	2,847
18	2,867	2,886	2,905	2,925	2,944	2,963	2,983	3,002	3,022	3,042
19	3,061	3,081	3,100	3,120	3,140	3,160	3,180	3,199	3,219	3,239
20	3,259	3,279	3,299	3,319	3,340	3,360	3,380	3,400	3,420	3,441
21	3,461	3,482	3,502	3,522	3,543	3,563	3,584	3,605	3,625	3,646
22	3,667	3,687	3,708	3,729	3,750	3,771	3,792	3,813	3,834	3,855
23	3,876	3,897	3,918	3,939	3,961	3,982	4,003	4,025	4,046	4,067
24	4,089	4,110	4,132	4,154	4,175	4,197	4,218	4,240	4,262	4,284
25	4,306	4,327	4,349	4,371	4,393	4,415	4,437	4,459	4,482	4,504
26	4,526	4,548	4,570	4,593	4,615	4,638	4,660	4,682	4,705	4,727
27	4,750	4,773	4,795	4,818	4,841	4,863	4,886	4,909	4,932	4,955
28	4,978	5,001	5,024	5,047	5,070	5,093	5,116	5,139	5,163	5,186
29	5,209	5,233	5,256	5,279	5,303	5,326	5,350	5,374	5,397	5,421
30	5,444	5,468	5,492	5,516	5,540	5,563	5,587	5,611	5,635	5,659
31	5,683	5,707	5,732	5,756	5,780	5,804	5,828	5,853	5,877	5,902
32	5,926	5,950	5,975	5,999	6,024	6,049	6,073	6,098	6,123	6,147
33	6,172	6,197	6,222	6,247	6,272	6,297	6,322	6,347	6,372	6,397
34	6,422	6,447	6,473	6,498	6,523	6,549	6,574	6,599	6,625	6,650
35	6,676	6,702	6,727	6,753	6,778	6,804	6,830	6,856	6,882	6,907
36	6,933	6,959	6,985	7,011	7,037	7,063	7,090	7,116	7,142	7,168
37	7,194	7,221	7,247	7,274	7,300	7,326	7,353	7,379	7,406	7,433
38	7,459	7,486	7,513	7,539	7,566	7,593	7,620	7,647	7,674	7,701
39	7,728	7,755	7,782	7,809	7,836	7,863	7,891	7,918	7,945	7,973
40	8,000	8,027	8,055	8,082	8,110	8,138	8,165	8,193	8,220	8,248
41	8,276	8,304	8,332	8,359	8,387	8,415	8,443	8,471	8,499	8,527
42	8,556	8,584	8,612	8,640	8,668	8,697	8,725	8,754	8,782	8,810
43	8,839	8,867	8,896	8,925	8,953	8,982	9,011	9,039	9,068	9,097
44	9,126	9,155	9,184	9,213	9,242	9,271	9,299	9,329	9,358	9,387
45	9,417	9,446	9,475	9,505	9,534	9,563	9,593	9,622	9,652	9,682
46	9,711	9,741	9,770	9,800	9,830	9,860	9,890	9,919	9,949	9,979
47	10,009	10,039	10,069	10,099	10,130	10,160	10,190	10,220	10,250	10,281
48	10,311	10,342	10,372	10,402	10,433	10,463	10,494	10,525	10,555	10,586
49	10,617	10,647	10,678	10,709	10,740	10,771	10,802	10,833	10,864	10,895
50	10,926	10,957	10,988	11,019	11,051	11,082	11,113	11,145	11,176	11,207
51	11,239	11,260	11,292	11,324	11,355	11,387	11,428	11,460	11,492	11,524
52	11,556	11,587	11,619	11,651	11,683	11,715	11,747	11,779	11,812	11,844
53	11,876	11,908	11,940	11,973	12,005	12,038	12,070	12,102	12,135	12,167
54	12,200	12,233	12,265	12,298	12,331	12,363	12,396	12,429	12,463	12,496
55	12,528	12,561	12,594	12,627	12,660	12,693	12,726	12,760	12,793	12,826
56	12,859	12,893	12,926	12,959	12,993	13,026	13,060	13,094	13,127	13,161
57	13,194	13,228	13,262	13,296	13,329	13,363	13,397	13,431	13,465	13,499
58	13,533	13,567	13,602	13,636	13,670	13,704	13,738	13,773	13,807	13,842
59	13,876	13,910	13,945	13,979	14,014	14,049	14,083	14,118	14,153	14,187
60	14,222	14,257	14,292	14,327	14,362	14,397	14,432	14,467	14,502	14,537

TABLE No. VII.

SLOPE ½ TO 1.

CORRECTION FOR DIFFERENCES OF DEPTHS.

	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
ft.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.
1	0	0	0	0	0	0	0	0	0	0
2	1	1	1	1	1	1	1	1	1	1
3	1	2	2	2	2	2	2	2	2	2
4	2	3	3	3	3	3	3	3	3	4
5	4	4	4	4	5	5	5	5	5	5
6	6	6	6	6	6	7	7	7	7	7
7	8	8	8	8	8	8	9	9	9	10
8	10	10	10	11	11	11	11	12	12	12
9	12	13	13	13	13	14	14	15	15	15
10	15	16	16	16	17	17	17	18	18	19
11	19	19	19	20	20	20	21	21	21	22
12	22	23	23	23	24	24	25	25	26	26
13	26	26	27	27	28	28	29	29	29	30
14	30	31	31	32	32	32	33	33	34	34
15	35	35	36	36	37	37	38	38	39	39
16	40	40	41	41	42	42	43	43	44	44
17	45	45	46	46	47	47	48	48	49	49
18	50	51	51	52	52	53	53	54	55	55
19	56	56	57	57	58	59	59	60	60	61
20	62	62	63	64	64	65	65	66	67	67
21	68	69	69	70	71	71	72	73	73	74
22	75	75	76	77	77	78	78	79	80	81
23	82	82	83	84	84	85	86	87	87	88
24	89	90	90	91	92	93	93	94	95	96
25	96	97	98	99	100	100	101	102	103	104
26	104	105	106	107	108	108	109	110	111	112
27	112	113	114	115	116	117	118	118	119	120
28	121	122	123	124	124	125	126	127	128	129
29	130	131	132	132	133	134	135	136	137	138
30	139	140	141	142	143	144	144	145	146	147
31	148	149	150	151	152	153	154	155	156	157
32	158	159	160	161	162	163	164	165	166	167
33	168	169	170	171	172	173	174	175	176	177
34	178	179	181	182	183	184	185	186	187	188
35	189	190	191	192	193	194	196	197	198	199
36	200	201	202	203	204	206	207	208	209	210
37	211	212	214	215	216	217	218	219	220	222
38	223	224	225	226	228	229	230	231	232	234
39	235	236	237	238	240	241	242	243	244	245
40	247	248	249	251	252	253	254	256	257	258
41	259	261	262	263	264	266	267	268	270	271
42	272	274	275	276	277	279	280	281	283	284
43	285	287	288	289	291	292	293	295	296	297
44	299	300	301	303	304	306	307	308	310	311
45	313	314	315	317	318	319	321	322	324	325

TABLE No. VIII.

SLOPE 1 TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 15 FEET.

Feet.	·0 c. yds.	·1 c. yds.	·2 c. yds.	·3 c. yds.	·4 c. yds.	·5 c. yds.	·6 c. yds.	·7 c. yds.	·8 c. yds.	·9 c. yds.
0	0	6	11	17	23	29	35	41	47	53
1	59	66	72	79	85	92	98	105	112	119
2	126	133	140	147	155	161	168	176	184	190
3	200	208	216	224	232	240	248	256	265	273
4	281	290	299	307	316	325	334	343	352	361
5	370	380	389	399	408	418	427	437	447	457
6	467	477	487	497	507	548	528	539	549	560
7	570	581	592	603	614	625	636	647	659	670
8	681	693	705	716	728	740	752	764	776	788
9	800	812	825	837	850	862	875	887	900	913
10	926	939	952	965	978	992	1,005	1,019	1,032	1,046
11	1,059	1,073	1,087	1,101	1,115	1,129	1,142	1,157	1,171	1,186
12	1,200	1,215	1,229	1,244	1,258	1,273	1,288	1,303	1,318	1,333
13	1,348	1,363	1,379	1,394	1,410	1,425	1,441	1,456	1,472	1,488
14	1,504	1,520	1,536	1,552	1,568	1,584	1,601	1,617	1,634	1,650
15	1,667	1,683	1,700	1,717	1,734	1,751	1,768	1,785	1,802	1,820
16	1,837	1,855	1,872	1,890	1,907	1,925	1,943	1,961	1,979	1,997
17	2,014	2,033	2,051	2,070	2,088	2,107	2,125	2,144	2,163	2,181
18	2,200	2,219	2,238	2,257	2,276	2,295	2,315	2,334	2,354	2,373
19	2,393	2,412	2,432	2,452	2,472	2,492	2,512	2,532	2,552	2,572
20	2,593	2,613	2,634	2,654	2,675	2,695	2,716	2,737	2,758	2,779
21	2,800	2,821	2,842	2,864	2,885	2,907	2,928	2,950	2,971	2,993
22	3,015	3,037	3,059	3,081	3,103	3,125	3,147	3,170	3,192	3,214
23	3,237	3,260	3,282	3,305	3,328	3,351	3,374	3,397	3,420	3,443
24	3,467	3,490	3,514	3,537	3,561	3,584	3,608	3,633	3,656	3,680
25	3,704	3,728	3,752	3,776	3,801	3,825	3,850	3,874	3,899	3,923
26	3,948	3,973	3,998	4,023	4,048	4,073	4,098	4,124	4,149	4,175
27	4,200	4,226	4,251	4,277	4,303	4,329	4,355	4,381	4,407	4,433
28	4,459	4,486	4,512	4,539	4,565	4,592	4,618	4,645	4,672	4,699
29	4,726	4,753	4,780	4,707	4,835	4,862	4,890	4,917	4,945	4,972
30	5,000	5,028	5,056	5,084	5,112	5,140	5,168	5,196	5,225	5,253
31	5,281	5,310	5,339	5,367	5,396	5,425	5,454	5,483	5,512	5,541
32	5,570	5,600	5,629	5,659	5,688	5,718	5,747	5,777	5,807	5,437
33	5,867	5,897	5,927	5,957	5,987	6,018	6,048	6,079	6,109	6,140
34	6,170	6,201	6,232	6,263	6,294	6,325	6,356	6,387	6,419	6,450
35	6,481	6,513	6,545	6,576	6,608	6,640	6,672	6,704	6,736	6,768
36	6,800	6,832	6,865	6,897	6,930	6,962	6,995	7,027	7,060	7,093
37	7,126	7,159	7,192	7,225	7,258	7,292	7,325	7,359	7,392	7,426
38	7,459	7,493	7,527	7,561	7,595	7,629	7,663	7,697	7,631	7,766
39	7,800	7,835	7,869	7,904	7,938	7,973	8,008	8,043	8,078	8,113
40	8,148	8,183	8,219	8,254	8,290	8,325	8,361	8,396	8,432	8,468
41	8,504	8,540	8,576	8,612	8,648	8,684	8,721	8,757	8,794	8,830
42	8,867	8,903	8,940	8,977	9,014	9,051	9,088	9,125	9,152	9,200
43	9,237	9,275	9,312	9,350	9,387	9,425	9,463	9,501	9,539	9,577
44	9,615	9,653	9,691	9,730	9,768	9,807	9,845	9,884	9,922	9,961
45	10,000	10,039	10,078	10,117	10,156	10,195	10,235	10,274	10,314	10,353
46	10,393	10,432	10,472	10,512	10,552	10,592	10,632	10,672	10,712	10,752
47	10,793	10,833	10,874	10,914	10,955	10,995	11,036	11,077	11,118	11,159
48	11,200	11,241	11,282	11,324	11,365	11,407	11,448	11,490	11,531	11,573
49	11,615	11,657	11,699	11,741	11,783	11,825	11,867	11,910	11,952	11,994
50	12,037	12,080	12,122	12,165	12,208	12,251	12,294	12,337	12,380	12,423
51	12,467	12,510	12,554	12,597	12,641	12,684	12,728	12,772	12,816	12,860
52	12,904	12,948	12,992	13,036	13,081	13,125	13,170	13,214	13,259	13,303
53	13,348	13,393	13,438	13,483	13,528	13,573	13,618	13,664	13,709	13,755
54	13,800	13,846	13,891	13,937	13,983	14,029	14,075	14,121	14,167	14,213
55	14,259	14,306	14,352	14,399	14,445	14,492	14,538	14,585	14,632	14,679
56	14,726	14,773	14,820	14,867	14,915	14,962	15,010	15,057	15,105	15,152
57	15,200	15,248	15,296	15,344	15,392	15,440	15,488	15,536	15,585	15,633
58	15,681	15,730	15,779	15,827	15,876	15,925	15,974	16,023	16,072	16,121
59	16,170	16,220	16,269	16,319	16,368	16,418	16,467	16,517	16,567	16,617
60	16,667	16,717	16,767	16,817	16,868	16,918	16,968	17,018	17,069	17,120

TABLE No. IX.

SLOPE 1 TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 18 FEET.

Feet.	·0 c. yds.	·1 c. yds.	·2 c. yds.	·3 c. yds.	·4 c. yds.	·5 c. yds.	·6 c. yds.	·7 c. yds.	·8 c. yds.	·9 c. yds.
0	0	7	13	20	27	34	41	48	56	63
1	70	78	85	93	101	108	116	124	132	140
2	148	156	165	173	181	190	198	207	216	224
3	233	242	251	260	270	279	288	297	307	316
4	326	336	345	355	365	375	385	395	405	416
5	426	436	447	457	468	479	490	500	511	522
6	533	545	556	567	578	590	601	613	625	636
7	648	660	672	684	696	708	721	733	745	758
8	770	783	796	809	821	834	847	860	874	887
9	900	913	927	940	954	968	981	995	1,009	1,023
10	1,037	1,051	1,065	1,080	1,094	1,108	1,123	1,137	1,152	1,167
11	1,181	1,196	1,211	1,226	1,241	1,257	1,272	1,287	1,302	1,318
12	1,333	1,349	1,365	1,380	1,396	1,412	1,428	1,444	1,460	1,476
13	1,493	1,509	1,525	1,542	1,558	1,575	1,592	1,609	1,625	1,642
14	1,659	1,676	1,694	1,711	1,728	1,745	1,763	1,780	1,798	1,816
15	1,833	1,851	1,869	1,887	1,905	1,923	1,941	1,960	1,978	1,996
16	2,015	2,033	2,052	2,071	2,090	2,108	2,127	2,146	2,165	2,185
17	2,204	2,223	2,242	2,262	2,281	2,301	2,321	2,340	2,360	2,380
18	2,400	2,420	2,440	2,460	2,481	2,501	2,521	2,542	2,562	2,583
19	2,604	2,625	2,645	2,666	2,687	2,708	2,730	2,751	2,772	2,793
20	2,815	2,836	2,858	2,880	2,901	2,923	2,945	2,967	2,989	3,011
21	3,033	3,056	3,078	3,100	3,123	3,145	3,168	3,191	3,214	3,236
22	3,259	3,282	3,305	3,328	3,351	3,375	3,398	3,422	3,445	3,469
23	3,493	3,516	3,540	3,564	3,598	3,622	3,646	3,670	3,697	3,721
24	3,733	3,758	3,782	3,807	3,832	3,857	3,881	3,906	3,931	3,956
25	3,981	4,007	4,032	4,057	4,083	4,108	4,134	4,160	4,185	4,211
26	4,237	4,263	4,289	4,315	4,341	4,368	4,394	4,420	4,447	4,473
27	4,500	4,527	4,554	4,580	4,607	4,634	4,661	4,689	4,716	4,743
28	4,770	4,798	4,825	4,853	4,881	4,908	4,936	4,964	4,992	5,020
29	5,048	5,076	5,105	5,133	5,161	5,190	5,218	5,247	5,276	5,305
30	5,333	5,362	5,391	5,420	5,450	5,479	5,508	5,537	5,567	5,596
31	5,626	5,656	5,685	5,715	5,745	5,775	5,805	5,835	5,865	5,896
32	5,926	5,956	5,987	6,017	6,048	6,079	6,110	6,140	6,171	6,202
33	6,233	6,265	6,296	6,327	6,358	6,390	6,421	6,453	6,485	6,516
34	6,548	6,580	6,612	6,644	6,676	6,708	6,741	6,773	6,805	6,838
35	6,870	6,903	6,936	6,969	7,001	7,034	7,067	7,100	7,134	7,167
36	7,200	7,233	7,267	7,300	7,334	7,368	7,401	7,435	7,469	7,503
37	7,537	7,571	7,605	7,640	7,674	7,708	7,743	7,777	7,812	7,847
38	7,881	7,916	7,951	7,986	8,021	8,057	8,092	8,127	8,162	8,198
39	8,233	8,269	8,305	8,340	8,376	8,412	8,448	8,484	8,520	8,556
40	8,592	8,629	8,665	8,702	8,738	8,775	8,812	8,849	8,885	8,922
41	8,959	8,996	9,034	9,071	9,108	9,145	9,183	9,220	9,258	9,296
42	9,333	9,371	9,409	9,447	9,485	9,523	9,561	9,600	9,638	9,676
43	9,715	9,753	9,792	9,831	9,870	9,908	9,947	9,986	10,025	10,065
44	10,104	10,143	10,182	10,222	10,261	10,301	10,341	10,380	10,420	10,460
45	10,500	10,540	10,580	10,620	10,660	10,701	10,741	10,782	10,822	10,863
46	10,904	10,945	10,985	11,026	11,067	11,108	11,150	11,191	11,232	11,273
47	11,315	11,356	11,398	11,440	11,481	11,523	11,565	11,607	11,649	11,691
48	11,733	11,776	11,818	11,860	11,903	11,945	11,988	12,031	12,074	12,115
49	12,159	12,201	12,244	12,288	12,331	12,374	12,417	12,462	12,505	12,549
50	12,593	12,636	12,680	12,724	12,768	12,812	12,856	12,900	12,945	12,989
51	13,033	13,078	13,122	13,167	13,212	13,257	13,301	13,346	13,391	13,436
52	13,482	13,527	13,572	13,617	13,662	13,708	13,754	13,800	13,845	13,891
53	13,937	13,983	14,029	14,075	14,121	14,168	14,214	14,260	14,307	14,353
54	14,400	14,447	14,494	14,540	14,587	14,634	14,681	14,729	14,776	14,823
55	14,870	14,918	14,965	15,013	15,061	15,108	15,156	15,204	15,252	15,300
56	15,348	15,396	15,445	15,493	15,541	15,590	15,638	15,687	15,736	15,785
57	15,833	15,882	15,931	15,980	16,030	16,079	16,128	16,177	16,227	16,276
58	16,326	16,376	16,425	16,475	16,525	16,575	16,625	16,675	16,725	16,776
59	16,826	16,876	16,926	16,977	17,028	17,079	17,130	17,180	17,231	17,282
60	17,333	17,384	17,436	17,487	17,538	17,590	17,641	17,693	17,745	17,796

TABLE No. X.

SLOPE 1 TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 25 FEET.

Feet.	·0 c. yds.	·1 c. yds.	·2 c. yds.	·3 c. yds.	·4 c. yds.	·5 c. yds.	·6 c. yds.	·7 c. yds.	·8 c. yds.	·9 c. yds.
0	0	9	19	28	38	47	57	66	76	86
1	96	106	116	127	137	147	158	168	179	189
2	200	211	222	233	244	255	266	277	288	300
3	311	323	334	346	358	369	381	393	405	417
4	430	442	454	467	479	492	504	517	530	543
5	556	569	582	595	608	621	635	648	662	675
6	689	703	716	730	744	758	772	787	801	815
7	830	844	859	873	888	903	918	933	948	963
8	978	993	1,008	1,024	1,039	1,055	1,070	1,086	1,102	1,117
9	1,133	1,149	1,165	1,181	1,198	1,214	1,230	1,247	1,263	1,280
10	1,296	1,313	1,330	1,347	1,364	1,381	1,398	1,415	1,432	1,449
11	1,467	1,484	1,502	1,519	1,537	1,555	1,572	1,590	1,608	1,626
12	1,644	1,663	1,681	1,699	1,718	1,736	1,755	1,773	1,792	1,811
13	1,830	1,849	1,868	1,887	1,906	1,925	1,944	1,964	1,983	2,003
14	2,022	2,042	2,062	2,081	2,101	2,121	2,141	2,161	2,182	2,202
15	2,222	2,243	2,263	2,284	2,304	2,325	2,346	2,367	2,388	2,409
16	2,430	2,451	2,472	2,493	2,515	2,536	2,558	2,579	2,601	2,623
17	2,644	2,666	2,688	2,711	2,733	2,756	2,778	2,800	2,822	2,844
18	2,867	2,889	2,912	2,935	2,958	2,981	3,004	3,027	3,050	3,073
19	3,096	3,120	3,143	3,167	3,190	3,214	3,238	3,261	3,285	3,309
20	3,333	3,357	3,381	3,406	3,430	3,455	3,479	3,504	3,528	3,553
21	3,578	3,603	3,628	3,653	3,678	3,703	3,728	3,753	3,779	3,804
22	3,830	3,855	3,881	3,907	3,932	3,958	3,984	4,010	4,036	4,063
23	4,089	4,115	4,142	4,168	4,195	4,221	4,248	4,275	4,302	4,329
24	4,356	4,383	4,410	4,437	4,464	4,492	4,519	4,547	4,574	4,602
25	4,630	4,657	4,685	4,713	4,741	4,769	4,798	4,826	4,854	4,883
26	4,911	4,940	4,968	4,997	5,026	5,055	5,084	5,113	5,142	5,171
27	5,200	5,229	5,259	5,288	5,318	5,347	5,377	5,407	5,436	5,466
28	5,496	5,526	5,556	5,586	5,617	5,647	5,678	5,708	5,739	5,769
29	5,800	5,831	5,862	5,893	5,924	5,955	5,986	6,017	6,048	6,080
30	6,111	6,142	6,174	6,206	6,238	6,269	6,301	6,333	6,365	6,397
31	6,430	6,462	6,494	6,527	6,559	6,592	6,624	6,657	6,690	6,723
32	6,756	6,789	6,822	6,855	6,888	6,921	6,955	6,988	7,022	7,055
33	7,089	7,123	7,156	7,190	7,224	7,258	7,292	7,327	7,361	7,395
34	7,430	7,464	7,499	7,533	7,568	7,603	7,638	7,673	7,708	7,743
35	7,778	7,813	7,848	7,884	7,919	7,955	7,990	8,026	8,062	8,097
36	8,133	8,169	8,205	8,241	8,278	8,314	8,350	8,387	8,423	8,460
37	8,496	8,533	8,570	8,607	8,644	8,681	8,718	8,755	8,792	8,829
38	8,867	8,904	8,942	8,979	9,017	9,055	9,092	9,130	9,168	9,206
39	9,244	9,283	9,321	9,359	9,398	9,436	9,475	9,513	9,552	9,591
40	9,629	9,669	9,708	9,747	9,786	9,825	9,864	9,904	9,943	9,983
41	10,022	10,062	10,102	10,141	10,181	10,221	10,261	10,301	10,342	10,382
42	10,422	10,463	10,503	10,544	10,584	10,625	10,666	10,707	10,748	10,788
43	10,830	10,871	10,912	10,953	10,995	11,036	11,078	11,119	11,161	11,203
44	11,244	11,286	11,328	11,370	11,412	11,455	11,497	11,539	11,582	11,624
45	11,667	11,709	11,752	11,795	11,837	11,880	11,923	11,966	12,010	12,053
46	12,096	12,140	12,183	12,227	12,270	12,314	12,358	12,401	12,445	12,489
47	12,533	12,577	12,622	12,666	12,710	12,755	12,799	12,844	12,888	12,933
48	12,978	13,023	13,068	13,113	13,158	13,203	13,248	13,293	13,339	13,384
49	13,430	13,475	13,521	13,567	13,612	13,658	13,704	13,750	13,796	13,843
50	13,889	13,935	13,982	14,028	14,075	14,121	14,168	14,215	14,262	14,309
51	14,356	14,403	14,450	14,497	14,544	14,592	14,639	14,687	14,734	14,782
52	14,830	14,877	14,925	14,973	15,021	15,069	15,118	15,166	15,214	15,203
53	15,311	15,360	15,408	15,457	15,506	15,555	15,604	15,653	15,702	15,751
54	15,800	15,849	15,899	15,948	15,998	16,047	16,097	16,147	16,196	16,246
55	16,296	16,346	16,396	16,447	16,497	16,547	16,598	16,648	16,699	16,749
56	16,800	16,851	16,902	16,953	17,004	17,055	17,106	17,157	17,208	17,260
57	17,311	17,363	17,414	17,466	17,518	17,569	17,621	17,673	17,725	17,777
58	17,830	17,882	17,934	17,987	18,039	18,092	18,144	18,197	18,250	18,303
59	18,356	18,409	18,462	18,515	19,568	18,621	18,675	18,728	18,782	18,835
60	18,889	18,943	18,996	19,050	19,104	19,158	19,212	19,267	19,321	19,375

TABLE No. XI.

SLOPE 1 TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 28 FEET.

Feet.	·0 c. yds.	·1 c. yds.	·2 c. yds.	·3 c. yds.	·4 c. yds.	·5 c. yds.	·6 c. yds.	·7 c. yds.	·8 c. yds.	·9 c. yds.
0	0	10	21	31	42	53	63	74	85	96
1	107	119	130	141	152	164	175	187	199	210
2	222	234	246	258	270	282	295	306	319	332
3	344	357	370	383	395	408	421	434	448	461
4	474	487	501	514	528	542	555	569	583	597
5	611	625	639	654	668	682	697	711	726	741
6	756	770	785	800	815	831	846	861	876	892
7	907	923	939	954	970	986	1,002	1,018	1,034	1,050
8	1,067	1,083	1,099	1,116	1,132	1,149	1,166	1,183	1,199	1,216
9	1,233	1,250	1,268	1,285	1,302	1,319	1,337	1,354	1,372	1,390
10	1,407	1,425	1,443	1,461	1,479	1,497	1,515	1,534	1,552	1,570
11	1,589	1,607	1,626	1,645	1,664	1,682	1,701	1,720	1,739	1,759
12	1,778	1,797	1,816	1,836	1,855	1,875	1,895	1,914	1,934	1,954
13	1,974	1,994	2,014	2,034	2,055	2,075	2,095	2,116	2,136	2,157
14	2,178	2,199	2,219	2,240	2,261	2,282	2,304	2,325	2,346	2,367
15	2,389	2,410	2,432	2,454	2,475	2,497	2,519	2,542	2,563	2,585
16	2,607	2,630	2,652	2,674	2,697	2,719	2,742	2,765	2,788	2,810
17	2,833	2,856	2,879	2,903	2,926	2,949	2,972	2,996	3,019	3,043
18	3,067	3,090	3,114	3,138	3,167	3,186	3,210	3,234	3,259	3,283
19	3,307	3,332	3,356	3,381	3,406	3,431	3,455	3,480	3,505	3,530
20	3,556	3,581	3,606	3,631	3,657	3,682	3,708	3,734	3,759	3,785
21	3,811	3,837	3,863	3,889	3,915	3,942	3,968	3,994	4,021	4,047
22	4,074	4,101	4,128	4,154	4,181	4,208	4,235	4,263	4,290	4,317
23	4,344	4,372	4,399	4,427	4,455	4,482	4,510	4,538	4,566	4,594
24	4,622	4,650	4,679	4,707	4,735	4,764	4,792	4,821	4,850	4,879
25	4,907	4,936	4,965	4,994	5,024	5,053	5,082	5,111	5,141	5,170
26	5,200	5,230	5,260	5,289	5,319	5,349	5,379	5,409	5,439	5,470
27	5,500	5,530	5,561	5,591	5,622	5,653	5,684	5,714	5,745	5,776
28	5,807	5,839	5,870	5,901	5,932	5,964	5,995	6,027	6,059	6,090
29	6,122	6,154	6,186	6,218	6,250	6,282	6,315	6,347	6,379	6,412
30	6,444	6,477	6,510	6,542	6,575	6,608	6,641	6,674	6,707	6,741
31	6,774	6,807	6,841	6,874	6,908	6,942	6,975	7,009	7,043	7,077
32	7,111	7,145	7,179	7,214	7,248	7,282	7,317	7,351	7,386	7,421
33	7,456	7,490	7,525	7,560	7,595	7,631	7,666	7,701	7,736	7,772
34	7,807	7,843	7,879	7,914	7,950	7,986	8,022	8,058	8,094	8,130
35	8,167	8,203	8,239	8,276	8,312	8,349	8,386	8,423	8,459	8,496
36	8,533	8,570	8,608	8,645	8,682	8,719	8,757	8,794	8,832	8,870
37	8,907	8,945	8,983	9,021	9,059	9,097	9,135	9,173	9,212	9,250
38	9,289	9,327	9,366	9,405	9,444	9,482	9,521	9,560	9,599	9,639
39	9,678	9,717	9,756	9,796	9,835	9,875	9,915	9,954	9,994	10,034
40	10,074	10,114	10,154	10,194	10,235	10,275	10,315	10,356	10,396	10,437
41	10,478	10,519	10,559	10,600	10,641	10,682	10,724	10,765	10,806	10,847
42	10,889	10,930	10,972	11,014	11,055	11,097	11,139	11,181	11,223	11,265
43	11,307	11,350	11,392	11,434	11,477	11,519	11,562	11,605	11,648	11,690
44	11,733	11,776	11,819	11,863	11,906	11,949	11,992	12,036	12,079	12,123
45	12,167	12,210	12,254	12,298	12,342	12,386	12,430	12,474	12,519	12,563
46	12,607	12,652	12,696	12,741	12,786	12,831	12,875	12,920	12,965	13,010
47	13,056	13,101	13,146	13,191	13,237	13,282	13,328	13,374	13,419	13,465
48	13,511	13,557	13,603	13,649	13,695	13,742	13,788	13,834	13,881	13,927
49	13,974	14,021	14,068	14,114	14,161	14,208	14,255	14,303	14,350	14,397
50	14,444	14,492	14,539	14,587	14,635	14,682	14,730	14,778	14,826	14,875
51	14,922	14,970	15,019	15,067	15,115	15,164	15,212	15,261	15,310	15,359
52	15,407	15,456	15,505	15,554	15,604	15,653	15,702	15,751	15,801	15,850
53	15,900	15,950	15,999	16,049	16,099	16,149	16,199	16,249	16,299	16,350
54	16,400	16,450	16,501	16,551	16,602	16,653	16,704	16,754	16,805	16,856
55	16,907	16,959	17,010	17,061	17,112	17,164	17,215	17,267	17,319	17,370
56	17,422	17,474	17,526	17,578	17,630	17,682	17,735	17,787	17,839	17,892
57	17,944	17,997	18,050	18,103	18,155	18,208	18,261	18,314	18,368	18,421
58	18,474	18,527	18,581	18,634	18,688	18,742	18,795	18,849	18,903	18,957
59	19,011	19,065	19,119	19,174	19,228	19,282	19,337	19,391	19,446	19,501
60	19,556	19,610	19,665	19,720	19,775	19,831	19,886	19,941	19,996	20,052

TABLE No. XII.

SLOPE 1 TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 30 FEET.

Feet.	·0 c. yds.	·1 c. yds.	·2 c. yds.	·3 c. yds.	·4 c. yds.	·5 c. yds.	·6 c. yds.	·7 c. yds.	·8 c. yds.	·9 c. yds.
0	0	11	22	34	45	56	68	79	91	103
1	115	127	139	151	163	175	187	199	212	224
2	237	250	262	275	288	301	314	327	340	353
3	367	380	393	407	421	434	448	462	476	490
4	504	518	532	546	561	575	589	604	619	633
5	648	663	678	693	708	723	738	754	769	784
6	800	816	831	847	863	879	895	911	927	943
7	959	976	992	1,008	1,025	1,042	1,058	1,075	1,092	1,109
8	1,126	1,143	1,160	1,177	1,195	1,212	1,229	1,247	1,265	1,282
9	1,300	1,318	1,336	1,354	1,372	1,390	1,408	1,426	1,445	1,463
10	1,481	1,500	1,519	1,537	1,556	1,575	1,594	1,613	1,632	1,651
11	1,670	1,690	1,709	1,729	1,748	1,768	1,787	1,807	1,827	1,847
12	1,867	1,887	1,907	1,927	1,947	1,968	1,988	2,008	2,029	2,050
13	2,070	2,091	2,112	2,133	2,154	2,175	2,196	2,217	2,239	2,260
14	2,281	2,303	2,325	2,346	2,368	2,390	2,412	2,434	2,456	2,478
15	2,500	2,522	2,544	2,567	2,589	2,612	2,634	2,657	2,680	2,703
16	2,726	2,749	2,772	2,795	2,818	2,842	2,865	2,888	2,912	2,936
17	2,959	2,983	3,007	3,031	3,054	3,079	3,103	3,127	3,151	3,175
18	3,200	3,224	3,249	3,273	3,298	3,323	3,348	3,373	3,398	3,423
19	3,448	3,473	3,498	3,524	3,549	3,575	3,601	3,626	3,652	3,678
20	3,703	3,729	3,756	3,782	3,808	3,834	3,860	3,887	3,913	3,940
21	3,966	3,993	4,020	4,047	4,074	4,101	4,128	4,155	4,182	4,209
22	4,237	4,264	4,292	4,319	4,347	4,375	4,403	4,431	4,458	4,486
23	4,515	4,543	4,571	4,599	4,628	4,656	4,685	4,713	4,742	4,771
24	4,800	4,829	4,858	4,887	4,916	4,945	4,974	5,004	5,033	5,063
25	5,092	5,122	5,152	5,182	5,212	5,242	5,272	5,302	5,332	5,362
26	5,392	5,423	5,453	5,484	5,514	5,545	5,576	5,607	5,638	5,669
27	5,700	5,731	5,762	5,793	5,825	5,856	5,888	5,919	5,951	5,983
28	6,015	6,047	6,079	6,111	6,143	6,175	6,207	6,239	6,272	6,304
29	6,337	6,369	6,402	6,435	6,468	6,500	6,534	6,567	6,600	6,633
30	6,666	6,700	6,733	6,767	6,801	6,834	6,868	6,902	6,936	6,970
31	7,004	7,038	7,072	7,106	7,141	7,175	7,209	7,244	7,279	7,313
32	7,348	7,383	7,418	7,453	7,488	7,523	7,558	7,594	7,629	7,664
33	7,700	7,736	7,771	7,807	7,843	7,879	7,915	7,951	7,987	8,023
34	8,059	8,096	8,132	8,168	8,205	8,242	8,278	8,315	8,352	8,389
35	8,426	8,463	8,500	8,537	8,575	8,612	8,649	8,687	8,725	8,762
36	8,800	8,838	8,876	8,914	8,951	8,990	9,028	9,066	9,105	9,143
37	9,181	9,220	9,259	9,279	9,336	9,375	9,414	9,453	9,492	9,531
38	9,570	9,610	9,649	9,688	9,728	9,768	9,807	9,847	9,887	9,927
39	9,967	10,007	10,047	10,087	10,127	10,168	10,208	10,248	10,289	10,330
40	10,370	10,411	10,452	10,493	10,534	10,575	10,616	10,657	10,699	10,740
41	10,781	10,823	10,865	10,906	10,948	10,990	11,032	11,074	11,116	11,158
42	11,200	11,242	11,285	11,327	11,369	11,412	11,455	11,497	11,540	11,583
43	11,626	11,669	11,712	11,755	11,798	11,842	11,885	11,928	11,972	12,016
44	12,059	12,103	12,147	12,191	12,235	12,279	12,323	12,367	12,411	12,456
45	12,500	12,544	12,589	12,634	12,678	12,723	12,768	12,813	12,858	12,903
46	12,948	12,993	13,039	13,084	13,129	13,275	13,321	13,466	13,512	13,558
47	13,404	13,450	13,496	13,542	13,588	13,634	13,681	13,727	13,773	13,820
48	13,667	13,913	13,960	14,007	14,054	14,101	14,148	14,195	14,242	14,290
49	14,337	14,384	14,432	14,480	14,527	14,575	14,623	14,671	14,719	14,767
50	14,815	14,863	14,912	14,960	15,008	15,056	15,105	15,154	15,202	15,251
51	15,300	15,349	15,398	15,447	15,496	15,545	15,595	15,644	15,693	15,743
52	15,793	15,842	15,892	15,942	15,992	16,041	16,092	16,142	16,192	16,242
53	16,293	16,343	16,393	16,444	16,495	16,545	16,596	16,647	16,698	16,749
54	16,800	16,851	16,902	16,954	17,005	17,056	17,108	17,160	17,211	17,263
55	17,315	17,367	17,419	17,471	17,523	17,575	17,627	17,680	17,732	17,785
56	17,837	17,890	17,942	17,995	18,048	18,101	18,154	18,207	18,260	18,313
57	18,367	18,420	18,473	18,527	18,581	18,634	18,688	18,742	18,796	18,850
58	18,904	18,958	19,012	19,066	19,121	19,175	19,230	19,284	19,339	19,393
59	19,448	19,503	19,558	19,613	19,678	19,723	19,778	19,834	19,889	19,944
60	20,000	20,056	20,111	20,167	20,223	20,279	20,335	20,391	20,447	20,503

TABLE No. XIII.

SLOPE 1 TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 34 FEET.

Feet.	·0 c. yds.	·1 c. yds.	·2 c. yds.	·3 c. yds.	·4 c. yds.	·5 c. yds.	·6 c. yds.	·7 c. yds.	·8 c. yds.	·9 c. yds.
0	0	13	25	38	51	64	77	90	103	116
1	130	143	156	170	184	197	211	225	239	253
2	267	281	295	309	324	338	352	367	382	396
3	411	426	441	456	471	486	501	517	532	547
4	573	589	604	620	636	652	668	684	700	706
5	722	739	755	771	788	805	821	838	855	872
6	889	906	923	940	958	975	992	1,010	1,028	1,045
7	1,063	1,081	1,099	1,117	1,135	1,153	1,171	1,189	1,208	1,226
8	1,244	1,263	1,282	1,300	1,319	1,338	1,357	1,376	1,395	1,414
9	1,433	1,453	1,472	1,491	1,511	1,531	1,550	1,570	1,590	1,610
10	1,630	1,650	1,670	1,690	1,710	1,731	1,751	1,771	1,792	1,813
11	1,833	1,854	1,875	1,896	1,917	1,938	1,959	1,980	2,002	2,023
12	2,044	2,066	2,088	2,109	2,131	2,153	2,175	2,197	2,219	2,241
13	2,263	2,285	2,308	2,330	2,352	2,375	2,398	2,420	2,443	2,466
14	2,489	2,512	2,535	2,558	2,581	2,605	2,628	2,651	2,675	2,699
15	2,722	2,746	2,770	2,794	2,818	2,842	2,866	2,890	2,914	2,939
16	2,963	2,987	3,012	3,037	3,061	3,086	3,111	3,136	3,161	3,186
17	3,211	3,236	3,262	3,287	3,312	3,338	3,364	3,389	3,415	3,441
18	3,467	3,493	3,519	3,545	3,571	3,597	3,624	3,650	3,676	3,703
19	3,730	3,756	3,783	3,810	3,837	3,864	3,891	3,918	3,945	3,973
20	4,000	4,027	4,055	4,083	4,110	4,138	4,166	4,194	4,222	4,250
21	4,298	4,306	4,334	4,363	4,391	4,319	4,348	4,376	4,505	4,534
22	4,563	4,592	4,621	4,650	4,679	4,708	4,738	4,767	4,796	4,826
23	4,856	4,885	4,915	4,945	4,975	5,005	5,035	5,065	5,095	5,125
24	5,156	5,186	5,216	5,247	5,278	5,308	5,339	5,370	5,401	5,432
25	5,463	5,494	5,525	5,557	5,588	5,619	5,651	5,683	5,714	5,746
26	5,778	5,810	5,842	5,874	5,906	5,938	5,970	6,003	6,035	6,067
27	6,100	6,133	6,165	6,198	6,231	6,264	6,297	6,330	6,363	6,396
28	6,430	6,463	6,496	6,530	6,564	6,597	6,631	6,665	6,699	6,733
29	6,767	6,801	6,835	6,869	6,904	6,938	6,972	7,007	7,042	7,076
30	7,111	7,146	7,181	7,216	7,251	7,286	7,321	7,357	7,392	7,427
31	7,463	7,499	7,534	7,570	7,606	7,642	7,678	7,714	7,750	7,786
32	7,822	7,859	7,895	7,931	7,968	8,005	8,041	8,078	8,115	8,152
33	8,189	8,226	8,263	8,300	8,338	8,375	8,412	8,450	8,488	8,525
34	8,563	8,601	8,639	8,677	8,715	8,753	8,791	8,829	8,868	8,906
35	8,944	8,983	9,022	9,060	9,099	9,138	9,177	9,216	9,255	9,294
36	9,333	9,373	9,412	9,451	9,491	9,531	9,570	9,610	9,650	9,690
37	9,730	9,770	9,810	9,850	9,890	9,931	9,971	10,011	10,052	10,093
38	10,133	10,174	10,215	10,256	10,297	10,338	10,379	10,420	10,462	10,503
39	10,544	10,586	10,628	10,669	10,711	10,753	10,795	10,837	10,879	10,921
40	10,963	11,005	11,048	11,090	11,132	11,175	11,218	11,260	11,303	11,346
41	11,389	11,432	11,475	11,518	11,561	11,605	11,648	11,691	11,735	11,779
42	11,822	11,866	11,910	11,954	11,998	12,042	12,086	12,130	12,174	12,219
43	12,263	12,307	12,352	12,397	12,441	12,486	12,531	12,576	12,621	12,666
44	12,711	12,756	12,802	12,847	12,892	12,938	12,984	13,029	13,075	13,121
45	13,167	13,213	13,259	13,305	13,351	13,397	13,444	13,490	13,536	13,583
46	13,630	13,676	13,723	13,770	13,817	13,864	13,911	13,958	14,005	14,053
47	14,100	14,147	14,195	14,243	14,290	14,338	14,386	14,434	14,482	14,530
48	14,578	14,626	14,674	14,723	14,771	14,819	14,868	14,917	14,965	15,014
49	15,063	15,112	15,161	15,210	15,259	15,308	15,358	15,407	15,456	15,506
50	15,556	15,605	15,655	15,705	15,755	15,805	15,855	15,905	15,955	16,005
51	16,056	16,106	16,156	16,207	16,258	16,308	16,359	16,410	16,461	16,512
52	16,563	16,614	16,665	16,717	16,768	16,819	16,871	16,923	16,974	17,026
53	17,078	17,130	17,182	17,234	17,286	17,338	17,390	17,443	17,495	17,547
54	17,600	17,653	17,705	17,758	17,811	17,864	17,917	17,970	18,023	18,076
55	18,130	18,183	18,236	18,290	18,344	18,397	18,451	18,105	18,559	18,613
56	18,667	18,721	18,775	18,829	18,884	18,938	18,992	19,047	18,102	19,156
57	19,211	19,266	19,321	19,376	19,431	19,486	19,541	19,597	19,652	19,707
58	19,763	19,819	19,874	19,930	19,986	20,042	20,098	20,154	20,210	20,266
59	20,322	20,379	20,435	20,491	20,548	20,605	20,661	20,718	20,775	20,832
60	20,889	20,946	21,003	21,060	21,118	21,175	21,232	21,290	21,348	21,504

March 1844,, begins here.

TABLE No. XIV.

SLOPE 1 TO 1.

CORRECTION FOR DIFFERENCES OF DEPTHS.

Feet.	·0 c. yds.	·1 c. yds.	·2 c. yds.	·3 c. yds.	·4 c. yds.	·5 c. yds.	·6 c. yds.	·7 c. yds.	·8 c. yds.	·9 c. yds.
1	0	0	0	1	1	1	1	1	1	1
2	1	1	1	2	2	2	2	2	2	3
3	3	3	3	3	4	4	4	4	4	5
4	5	5	5	6	6	6	7	7	7	7
5	8	8	8	9	9	9	10	10	10	11
6	11	11	12	12	13	13	13	14	14	15
7	15	16	16	16	17	17	18	18	19	19
8	20	20	21	21	22	22	23	23	24	24
9	25	26	26	27	27	28	28	29	30	30
10	31	31	32	33	33	34	35	35	36	37
11	37	38	39	39	40	41	42	42	43	44
12	44	45	46	47	47	48	49	50	50	51
13	52	53	54	55	55	56	57	58	59	60
14	60	61	62	63	64	65	66	67	68	69
15	69	70	71	72	73	74	75	76	77	78
16	79	80	81	82	83	84	85	86	87	88
17	89	90	91	92	93	95	96	97	98	99
18	100	101	102	103	104	106	107	108	109	110
19	111	113	114	115	116	117	119	120	121	122
20	123	125	126	127	128	130	131	132	134	135
21	136	137	139	140	141	143	144	145	147	148
22	149	151	152	153	155	156	158	159	160	162
23	163	165	166	168	169	170	172	173	175	176
24	178	179	181	182	184	185	187	188	190	191
25	193	194	196	198	199	201	202	204	205	207
26	209	210	212	213	215	217	218	220	222	223
27	225	227	228	230	232	233	235	237	239	240
28	242	244	245	247	249	251	252	254	256	258
29	260	261	263	265	267	269	270	272	274	276
30	278	280	281	283	285	287	289	291	293	295
31	297	298	300	302	304	306	308	310	312	314
32	316	318	320	322	324	326	328	330	332	334
33	336	338	340	342	344	346	348	350	353	355
34	357	359	361	363	365	367	369	372	374	376
35	378	380	382	385	387	389	391	393	396	398
36	400	402	404	407	409	411	413	416	418	420
37	423	425	427	429	432	434	436	439	441	443
38	446	448	450	453	455	457	460	462	465	467
39	469	472	474	477	479	482	484	486	489	491
40	494	496	499	501	504	506	509	511	514	516
41	519	521	524	526	529	531	534	537	539	541
42	544	547	550	552	555	558	560	563	565	568
43	571	573	576	579	581	584	587	589	592	595
44	598	600	603	606	608	611	614	617	619	622
45	625	628	631	633	636	639	642	645	647	650

TABLE No. XV.

SLOPE $1\frac{1}{2}$ TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 15 FEET.

Feet.	·0 c. yds.	·1 c. yds.	·2 c. yds.	·3 c. yds.	·4 c. yds.	·5 c. yds.	·6 c. yds.	·7 c. yds.	·8 c. yds.	·9 c. yds.
0	0	6	11	17	23	29	35	42	48	54
1	61	68	75	82	89	96	103	110	118	126
2	133	141	149	157	165	174	182	190	199	208
3	217	225	234	243	252	261	271	281	290	301
4	311	321	331	342	352	362	373	384	395	406
5	417	428	439	450	462	474	485	497	509	521
6	533	546	558	570	583	596	609	622	635	684
7	661	674	688	702	715	729	743	757	771	786
8	800	814	829	844	859	874	889	904	919	934
9	949	966	981	997	1,013	1,029	1,045	1,062	1,078	1,095
10	1,110	1,128	1,145	1,162	1,179	1,196	1,213	1,230	1,248	1,266
11	1,283	1,301	1,319	1,337	1,355	1,374	1,392	1,410	1,429	1,448
12	1,467	1,486	1,505	1,524	1,543	1,562	1,582	1,601	1,621	1,641
13	1,661	1,681	1,701	1,722	1,742	1,762	1,783	1,804	1,825	1,846
14	1,867	1,888	1,909	1,930	1,952	1,974	1,995	2,017	2,039	2,061
15	2,083	2,106	2,128	2,150	2,173	2,196	2,219	2,242	2,265	2,288
16	2,311	2,334	2,358	2,382	2,405	2,429	2,453	2,477	2,501	2,526
17	2,550	2,574	2,599	2,624	2,649	2,674	2,699	2,724	2,749	2,774
18	2,800	2,826	2,851	2,877	2,903	2,929	2,955	2,982	3,008	3,034
19	3,061	3,088	3,105	3,132	3,169	3,196	3,223	3,250	3,278	3,306
20	3,333	3,361	3,389	3,417	3,445	3,474	3,502	3,530	3,559	3,588
21	3,617	3,646	3,675	3,704	3,733	3,763	3,793	3,822	3,852	3,882
22	3,911	3,941	3,971	4,002	4,032	4,062	4,093	4,124	4,155	4,186
23	4,217	4,248	4,279	4,310	4,342	4,374	4,405	4,437	4,469	4,501
24	4,533	4,566	4,598	4,630	4,663	4,696	4,729	4,762	4,795	4,828
25	4,861	4,894	4,928	4,962	4,995	5,029	5,063	5,097	5,131	5,166
26	5,200	5,234	5,269	5,304	5,339	5,374	5,409	5,444	5,479	5,514
27	5,550	5,586	5,621	5,657	5,693	5,729	5,765	5,802	5,838	5,874
28	5,911	5,948	5,985	6,022	6,059	6,096	6,133	6,170	6,028	6,246
29	6,283	6,321	6,859	6,397	6,435	6,474	6,512	6,550	6,589	6,628
30	6,667	6,706	6,745	6,784	6,823	6,862	6,902	6,942	6,981	7,021
31	7,061	7,101	7,141	7,182	7,222	7,262	7,303	7,344	7,385	7,426
32	7,467	7,508	7,549	7,590	7,632	7,674	7,715	7,757	7,799	7,841
33	7,883	7,926	7,968	8,010	8,053	8,096	8,139	8,182	8,225	8,268
34	8,311	8,354	8,398	8,442	8,485	8,529	8,573	8,617	8,661	8,706
35	8,750	8,794	8,839	8,884	8,929	8,974	9,019	9,064	9,109	9,154
36	9,200	9,246	9,291	9,337	9,383	9,429	9,475	9,522	9,568	9,614
37	9,661	9,708	9,755	9,802	9,849	9,896	9,943	9,990	10,038	10,086
38	10,133	10,181	10,229	10,277	10,325	10,374	10,422	10,470	10,519	10,568
39	10,617	10,666	10,715	10,764	10,813	10,862	10,912	10,962	11,011	11,061
40	11,111	11,161	11,212	11,262	11,312	11,362	11,413	11,464	11,515	11,565
41	11,616	11,668	11,719	11,770	11,822	11,874	11,925	11,977	12,029	12,081
42	12,133	12,186	12,238	12,290	12,343	12,396	12,449	11,502	12,555	12,608
43	12,661	12,714	12,768	12,822	12,875	12,929	12,983	13,037	13,091	13,146
44	13,200	13,254	13,309	13,364	13,418	13,473	13,528	13,583	13,638	13,693
45	13,750	13,806	13,961	13,917	13,973	14,029	14,085	14,142	14,198	14,254
46	14,311	14,368	14,425	14,482	14,539	14,576	14,653	14,710	14,768	14,826
47	14,883	14,941	14,999	15,057	15,115	15,174	15,232	15,090	15,349	15,408
48	15,467	15,526	15,585	15,644	15,703	15,762	15,822	15,882	15,941	16,001
49	16,061	16,121	16,181	16,242	16,302	16,362	16,423	16,484	16,545	16,606
50	16,667	16,728	16,788	16,849	16,911	16,973	17,034	17,096	17,158	17,220
51	17,283	17,346	17,408	17,470	17,533	17,596	17,659	17,722	17,785	17,848
52	17,911	17,975	18,038	18,102	18,165	18,229	18,293	18,357	18,421	18,486
53	18,550	18,614	18,679	18,744	18,809	18,874	18,939	19,004	19,069	19,134
54	19,200	19,266	19,331	19,397	19,463	19,529	19,595	19,662	19,728	19,794
55	19,861	19,928	19,995	20,062	20,129	20,196	20,263	20,330	20,408	20,476
56	20,533	20,601	20,669	20,737	20,805	20,874	20,942	21,011	21,079	21,148
57	21,217	21,286	21,355	21,424	21,493	21,562	21,632	21,702	21,771	21,841
58	21,911	21,981	22,051	22,122	22,192	22,262	22,333	22,404	22,475	22,546
59	22,617	22,688	22,759	22,830	22,902	22,974	23,045	23,117	23,189	23,261
60	23,333	23,406	23,478	23,550	23,623	23,696	23,769	23,842	23,915	23,988

TABLE No. XVI.

SLOPE $1\frac{1}{2}$ TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 18 FEET.

Feet.	·0 c. yds.	·1 c. yds.	·2 c. yds.	·3 c. yds.	·4 c. yds.	·5 c. yds.	·6 c. yds.	·7 c. yds.	·8 c. yds.	·9 c. yds.
0	0	7	14	20	28	35	42	49	57	65
1	72	80	88	96	104	112	121	129	138	147
2	156	164	174	183	192	201	211	220	230	240
3	250	260	270	280	291	301	312	323	334	344
4	356	367	378	389	401	412	424	436	448	460
5	472	484	497	509	522	535	548	560	574	587
6	600	613	627	640	654	668	682	696	710	724
7	739	753	768	782	797	812	828	843	858	873
8	889	904	920	936	952	968	984	1,000	1,017	1,033
9	1,050	1,067	1,084	1,100	1,118	1,135	1,152	1,169	1,187	1,204
10	1,222	1,240	1,258	1,276	1,294	1,312	1,331	1,349	1,368	1,387
11	1,406	1,424	1,444	1,463	1,482	1,501	1,521	1,540	1,560	1,580
12	1,600	1,620	1,640	1,660	1,681	1,701	1,722	1,743	1,764	1,784
13	1,806	1,827	1,848	1,869	1,891	1,912	1,934	1,956	1,978	2,000
14	2,022	2,044	2,067	2,089	2,112	2,135	2,158	2,180	2,204	2,227
15	2,250	2,273	2,297	2,320	2,344	2,368	2,392	2,416	2,440	2,464
16	2,489	2,513	2,538	2,563	2,588	2,612	2,638	2,663	2,688	2,713
17	2,739	2,764	2,790	2,816	2,842	2,868	2,894	2,920	2,947	2,973
18	3,000	3,027	3,054	3,080	3,108	3,135	3,162	3,189	3,217	3,244
19	3,272	3,300	3,328	3,356	3,384	3,412	3,441	3,469	3,498	3,527
20	3,556	3,584	3,614	3,643	3,672	3,701	3,731	3,760	3,790	3,820
21	3,850	3,880	3,910	3,940	3,971	4,001	4,032	4,063	4,094	4,124
22	4,156	4,187	4,218	4,249	4,281	4,312	4,344	4,376	4,408	4,440
23	4,472	4,504	4,537	4,569	4,602	4,635	4,668	4,700	4,734	4,767
24	4,800	4,833	4,867	4,900	4,934	4,968	5,002	5,036	5,070	5,104
25	5,139	5,173	5,208	5,243	5,278	5,312	5,348	5,383	5,418	5,453
26	5,489	5,524	5,560	5,596	5,632	5,668	5,704	5,740	5,777	5,813
27	5,850	5,887	5,924	5,960	5,998	6,035	6,072	6,109	6,147	6,184
28	6,222	6,260	6,298	6,336	6,374	6,412	6,451	6,489	6,528	6,567
29	6,606	6,644	6,684	6,723	6,762	6,801	6,841	6,880	6,920	6,960
30	7,000	7,040	7,080	7,120	7,161	7,201	7,242	7,283	7,324	7,364
31	7,406	7,447	7,488	7,529	7,571	7,612	7,654	7,696	7,738	7,780
32	7,822	7,864	7,907	7,949	7,992	8,035	8,078	8,120	8,164	8,207
33	8,250	8,293	8,337	8,380	8,424	8,468	8,512	8,556	8,600	8,644
34	8,689	8,733	8,778	8,823	8,868	8,912	8,958	9,003	9,048	9,093
35	9,139	9,184	9,230	9,276	9,322	9,368	9,414	9,460	9,507	9,553
36	9,600	9,647	9,694	9,740	9,788	9,835	9,882	9,929	9,977	10,024
37	10,072	10,120	10,168	10,216	10,264	10,312	10,361	10,409	10,458	10,507
38	10,556	10,604	10,654	10,703	10,752	10,801	10,851	10,900	10,950	11,000
39	11,050	11,100	11,150	11,200	11,251	11,301	11,352	11,403	11,454	11,504
40	11,556	11,607	11,658	11,709	11,761	11,812	11,864	11,916	11,968	12,020
41	12,072	12,124	12,177	12,229	12,282	12,335	12,388	12,440	12,493	12,547
42	12,600	12,653	12,707	12,760	12,814	12,868	12,922	12,976	13,030	13,084
43	13,139	13,193	13,248	13,303	13,358	13,412	13,468	13,523	13,578	13,633
44	13,689	13,744	13,800	13,856	13,912	13,968	14,024	14,080	14,137	14,193
45	14,250	14,307	14,364	14,420	14,478	14,535	14,592	14,649	14,707	14,764
46	14,822	14,880	14,938	14,996	15,054	15,102	15,161	15,229	15,288	15,347
47	15,406	15,464	15,524	15,583	15,642	15,701	15,761	15,820	15,880	15,940
48	16,000	16,060	16,120	16,180	16,241	16,301	16,362	16,423	16,484	16,544
49	16,606	16,667	16,728	16,789	16,851	16,912	16,974	17,036	17,098	17,160
50	17,222	17,284	17,347	17,409	17,472	17,535	17,598	17,660	17,724	17,787
51	17,850	17,913	17,977	18,040	18,104	18,168	18,232	18,296	18,360	18,424
52	18,489	18,553	18,618	18,683	18,748	18,812	18,878	18,943	19,008	19,073
53	19,139	19,204	19,270	19,336	19,402	19,468	19,534	19,600	19,667	19,733
54	19,800	19,867	19,934	20,000	20,068	20,135	20,202	20,269	20,337	20,404
55	20,472	20,540	20,608	20,676	20,744	20,812	20,881	20,949	21,018	21,087
56	21,156	21,224	21,294	21,363	21,432	21,501	21,571	21,640	21,710	21,780
57	21,850	21,920	21,990	22,060	22,131	22,201	22,272	22,343	22,414	22,484
58	22,556	22,627	22,698	22,769	22,841	22,912	22,984	23,056	23,128	23,200
59	23,272	23,344	23,417	23,489	23,562	23,635	23,708	23,780	23,854	23,927
60	24,000	24,073	24,147	24,220	24,294	24,368	24,442	24,516	24,590	24,664

TABLE No. XVII.

SLOPE $1\frac{1}{2}$ TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 25 FEET.

Feet.	·0 c. yds.	·1 c. yds.	·2 c. yds.	·3 c. yds.	·4 c. yds.	·5 c. yds.	·6 c. yds.	·7 c. yds.	·8 c. yds.	·9 c. yds.
0	0	9	19	28	38	48	58	68	78	88
1	98	109	119	130	141	151	162	173	185	199
2	207	219	231	242	254	266	278	290	303	315
3	328	340	353	366	379	392	405	419	432	446
4	459	473	487	501	515	529	543	558	572	587
5	602	617	632	647	662	677	693	708	724	740
6	756	772	788	804	820	837	853	870	887	903
7	920	937	955	972	989	1,007	1,025	1,042	1,060	1,078
8	1,096	1,114	1,133	1,151	1,170	1,188	1,207	1,226	1,245	1,264
9	1,283	1,303	1,322	1,342	1,361	1,381	1,401	1,421	1,441	1,461
10	1,481	1,502	1,522	1,543	1,564	1,585	1,606	1,627	1,648	1,669
11	1,691	1,712	1,734	1,756	1,778	1,800	1,822	1,844	1,866	1,889
12	1,911	1,934	1,957	1,979	2,002	2,025	2,049	2,072	2,095	2,119
13	2,143	2,166	2,190	2,214	2,238	2,262	2,287	2,311	2,336	2,360
14	2,385	2,410	2,435	2,460	2,485	2,511	2,536	2,562	2,587	2,613
15	2,639	2,665	2,691	2,717	2,743	2,770	2,796	2,823	2,850	2,877
16	2,904	2,931	2,958	2,985	3,013	3,040	3,068	3,096	3,124	3,152
17	3,180	3,208	3,236	3,265	3,293	3,322	3,351	3,379	3,408	3,437
18	3,467	3,496	3,525	3,555	3,585	3,614	3,644	3,674	3,704	3,735
19	3,765	3,795	3,826	3,856	3,887	3,918	3,949	3,980	4,011	4,043
20	4,074	4,106	4,137	4,169	4,201	4,233	4,265	4,297	4,329	4,362
21	4,394	4,427	4,460	4,493	4,526	4,559	4,592	4,625	4,659	4,692
22	4,726	4,760	4,794	4,828	4,862	4,896	4,930	4,965	4,999	5,034
23	5,069	5,103	5,138	5,173	5,209	5,244	5,279	5,315	5,351	5,386
24	5,422	5,458	5,494	5,530	5,567	5,603	5,640	5,676	5,713	5,750
25	5,787	5,824	5,861	5,899	5,936	5,974	6,011	6,049	6,087	6,125
26	6,163	6,201	6,239	6,278	6,316	6,355	6,394	6,433	6,472	6,511
27	6,550	6,589	6,629	6,668	6,708	6,748	6,788	6,828	6,868	6,908
28	6,948	6,989	7,029	7,070	7,111	7,151	7,192	7,233	7,275	7,316
29	7,357	7,399	7,441	7,482	7,524	7,566	7,608	7,651	7,693	7,735
30	7,778	7,820	7,863	7,906	7,949	7,992	8,035	8,079	8,122	8.166
31	8,209	8,253	8,297	8,341	8,385	8,429	8,473	8,518	8,562	8,607
32	8,652	8,697	8,742	8,787	8,832	8,877	8,923	8,968	9,014	9,060
33	9,106	9,152	9,198	9,244	9,290	9,337	9,383	9,430	9,477	9,523
34	9,570	9,617	9,665	9,712	9,759	9,807	9,855	9,902	9,950	9,998
35	10,046	10,094	10,143	10,191	10,240	10,288	10,337	10,386	10,435	10,484
36	10,533	10,583	10,632	10,682	10,731	10,781	10,831	10,881	10,931	10,981
37	11,031	11,082	11,132	11,183	11,234	11,285	11,336	11,387	11,438	11,489
38	11,541	11,592	11,644	11,696	11,748	11,800	11,852	11,904	11,956	12,009
39	12,061	12,114	12,167	12,219	12,272	12,325	12,379	12,432	12,485	12,539
40	12,593	12,646	12,700	12,754	12,808	12,862	12,917	12,971	13,026	13,080
41	13,135	13,190	13,245	13,300	13,355	13,411	13,466	13,522	13,577	13,633
42	13,689	13,745	13,801	13,857	13,913	13,970	14,026	14,083	14,140	14,197
43	14,254	14,311	14,368	14,425	14,483	14,540	14,598	14,656	14,714	14,772
44	14,830	14,888	14,946	15,005	15,063	15,122	15,181	15,239	15,298	15,357
45	15,417	15,476	15,535	15,595	15,655	15,714	15,774	15,834	15,894	15,954
46	16,015	16,075	16,136	16,196	16,257	16,318	16,379	16,440	16,501	16,563
47	16,624	16,686	16,747	16,809	16,871	16,933	16,995	17,057	17,119	17,182
48	17,244	17,307	17,370	17,433	17,496	17,559	17,622	17,685	17,749	17,812
49	17,876	17,940	18,004	18,068	18,132	18,196	18,260	18,325	18,389	18,454
50	18,519	18,583	18,648	18,713	18,779	18,844	18,909	18,975	19,041	19,106
51	19,172	19,238	19,304	19,370	19,437	19,503	19,570	19,636	19,703	19,770
52	19,837	19,904	19,971	20,039	20,106	20,174	20,241	20,309	20,377	20,445
53	20,513	20,581	20,649	20,718	20,786	20,855	20,924	20,993	21,062	21,131
54	21,200	21,269	21,339	21,408	21,478	21,548	21,618	21,688	21,758	21,828
55	21,898	21,969	22,039	22,110	22,181	22,251	22,322	22,393	22,465	22,536
56	22,607	22,679	22,751	22,822	22,894	22,966	23,038	23,111	23,183	23,255
57	23,328	23,400	23,473	23,546	23,619	23,692	23,765	23,839	23,912	23,986
58	24,059	24,133	24,207	24,281	24,355	24,429	24,503	24,578	24,652	24,727
59	24,802	24,877	24,952	25,027	25,102	25,177	25,253	25,328	25,404	25,480
60	25,556	25,632	25,708	25,784	25,860	25,937	25,013	26,090	26,167	26,243

TABLE No. XVIII.

SLOPE 1½ TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 28 FEET.

Feet.	·0 c. yds.	·1 c. yds.	·2 c. yds.	·3 c. yds.	·4 c. yds.	·5 c. yds.	·6 c. yds.	·7 c. yds.	·8 c. yds.	·9 c. yds.
0	0	10	20	31	42	53	64	75	86	97
1	109	120	132	144	156	168	180	192	204	217
2	229	242	255	267	280	293	307	320	333	347
3	361	374	388	402	416	431	445	459	474	488
4	503	518	533	548	563	579	594	610	625	641
5	657	673	689	705	721	738	754	771	788	805
6	822	839	856	873	891	908	926	944	962	980
7	998	1,016	1,034	1,043	1,061	1,080	1,099	1,117	1,136	1,155
8	1,185	1,204	1,223	1,243	1,263	1,282	1,302	1,322	1,342	1,363
9	1,383	1,403	1,424	1,444	1,465	1,486	1,507	1,528	1,549	1,571
10	1,592	1,614	1,635	1,657	1,679	1,701	1,723	1,745	1,768	1,790
11	1,812	1,835	1,858	1,881	1,904	1,927	1,950	1,973	1,997	2,020
12	2,044	2,068	2,092	2,116	2,140	2,164	2,188	2,213	2,237	2,262
13	2,287	2,311	2,336	2,361	2,387	2,412	2,437	2,463	2,489	2,514
14	2,540	2,566	2,592	2,619	2,645	2,671	2,698	2,724	2,751	2,778
15	2,805	2,832	2,859	2,887	2,914	2,942	2,969	2,997	3,025	3,053
16	3,081	3,109	3,137	3,166	3,194	3,223	3,252	3,281	3,310	3,339
17	3,368	3,397	3,427	3,456	3,486	3,546	3,546	3,576	3,606	3,636
18	3,667	3,697	3,727	3,758	3,789	3,819	3,850	3,881	3,913	3,944
19	3,975	4,007	4,039	4,070	4,102	4,134	4,166	4,199	4,231	4,263
20	4,296	4,328	4,361	4,394	4,427	4,460	4,493	4,527	4,560	4,594
21	4,627	4,661	4,695	4,729	4,763	4,797	4,832	4,866	4,900	4,935
22	4,970	5,005	5,040	5,075	5,110	5,145	5,181	5,216	5,252	5,288
23	5,324	5,360	5,396	5,432	5,468	5,505	5,541	5,578	5,615	5,651
24	5,688	5,725	5,763	5,800	5,837	5,875	5,913	5,950	5,988	6,026
25	6,064	6,103	6,141	6,179	6,218	6,256	6,295	6,334	6,373	6,412
26	6,451	6,491	6,530	6,570	6,609	6,649	6,689	6,729	6,769	6,809
27	6,850	6,890	6,930	6,971	7,012	7,053	7,094	7,135	7,176	7,217
28	7,259	7,300	7,342	7,384	7,426	7,468	7,510	7,552	7,594	7,637
29	7,679	7,722	7,765	7,807	7,850	7,893	7,937	7,980	8,023	8,067
30	8,111	8,154	8,198	8,242	8,286	8,331	8,375	8,419	8,464	8,508
31	8,553	8,598	8,643	8,688	8,733	8,779	8,824	8,870	8,915	8,961
32	9,007	9,053	9,099	9,145	9,191	9,238	9,284	9,331	9,378	9,425
33	9,472	9,519	9,566	9,613	9,661	9,708	9,756	9,804	9,852	9,900
34	9,948	9,996	10,044	10,093	10,141	10,190	10,239	10,287	10,336	10,385
35	10,435	10,484	10,533	10,583	10,633	10,682	10,732	10,782	10,832	10,883
36	10,933	10,983	11,034	11,084	11,135	11,186	11,237	11,288	11,339	11,391
37	11,442	11,494	11,545	11,597	11,649	11,701	11,753	11,805	11,858	11,910
38	11,962	12,015	12,068	12,121	12,174	12,227	12,280	12,333	12,387	12,440
39	12,494	12,548	12,602	12,656	12,710	12,764	12,818	12,873	12,927	12,982
40	13,037	13,091	13,146	13,201	13,257	13,312	13,367	13,423	13,479	13,534
41	13,590	13,646	13,702	13,759	13,815	13,871	13,928	13,984	14,041	14,098
42	14,155	14,212	14,269	14,327	14,384	14,442	14,499	14,557	14,615	14,673
43	14,731	14,789	14,848	14,906	14,964	15,023	15,082	15,141	15,200	15,259
44	15,318	15,377	15,437	15,496	15,556	15,616	15,676	15,736	15,796	15,856
45	15,917	15,977	16,038	16,098	16,159	16,221	16,282	16,344	16,405	16,466
46	16,526	16,587	16,649	16,711	16,773	16,835	16,897	16,959	17,021	17,084
47	17,146	17,209	17,272	17,335	17,398	17,461	17,524	17,587	17,651	17,714
48	17,778	17,842	17,905	17,969	18,033	18,098	18,162	18,226	18,291	18,356
49	18,420	18,485	18,550	18,615	18,681	18,746	18,811	18,877	18,942	19,008
50	19,074	19,140	19,206	19,272	19,339	19,405	19,472	19,538	19,605	19,672
51	19,739	19,806	19,873	19,941	20,008	20,076	20,143	20,211	20,279	20,347
52	20,415	20,483	20,551	20,620	20,688	20,757	20,826	20,895	20,964	21,033
53	21,102	21,171	21,241	21,310	21,380	21,450	21,519	21,589	21,659	21,730
54	21,800	21,870	21,941	22,012	22,082	22,153	22,224	22,295	22,367	22,438
55	22,509	22,581	22,652	22,724	22,796	22,868	22,940	23,012	23,085	23,157
56	23,230	23,302	23,375	23,448	23,521	23,594	23,667	23,740	23,814	23,887
57	23,961	24,035	24,109	24,183	24,257	24,331	24,405	24,480	24,554	24,629
58	24,704	24,779	24,854	24,929	25,004	25,079	25,155	25,230	25,306	25,382
59	25,457	25,533	25,609	25,686	25,762	25,838	25,915	25,992	26,068	26,145
60	26,222	26,299	26,377	26,454	26,531	26,609	26,686	26,764	26,842	26,920

TABLE No. XIX.

SLOPE $1\frac{1}{2}$ TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 30 FEET.

Feet.	·0 c. yds.	·1 c. yds.	·2 c. yds.	·3 c. yds.	·4 c. yds.	·5 c. yds.	·6 c. yds.	·7 c. yds.	·8 c. yds.	·9 c. yds.
0	0	11	22	34	45	57	69	80	92	104
1	117	129	141	154	166	179	192	205	218	231
2	244	258	271	285	299	312	326	340	355	369
3	383	398	412	427	442	457	472	487	502	518
4	533	549	565	580	596	612	629	645	661	678
5	694	711	728	745	762	779	796	814	831	849
6	867	884	902	920	939	957	975	994	1,012	1,031
7	1,050	1,069	1,088	1,107	1,126	1,146	1,165	1,185	1,205	1,224
8	1,244	1,264	1,285	1,305	1,325	1,346	1,366	1,387	1,408	1,429
9	1,450	1,471	1,492	1,514	1,535	1,557	1,579	1,600	1,622	1,644
10	1,667	1,689	1,711	1,734	1,756	1,779	1,802	1,825	1,848	1,871
11	1,894	1,918	1,941	1,965	1,988	2,012	2,036	2,060	2,084	2,109
12	2,133	2,158	2,182	2,207	2,232	2,257	2,282	2,307	2,332	2,358
13	2,383	2,409	2,435	2,460	2,486	2,512	2,539	2,565	2,591	2,618
14	2,644	2,671	2,698	2,725	2,752	2,779	2,806	2,834	2,861	2,889
15	2,917	2,944	2,972	3,000	3,029	3,057	3,085	3,114	3,142	3,171
16	3,200	3,229	3,258	3,287	3,316	3,346	3,375	3,405	3,435	3,464
17	3,494	3,524	3,555	3,585	3,615	3,646	3,676	3,707	3,738	3,769
18	3,800	3,831	3,862	3,894	3,925	3,957	3,989	4,020	4,052	4,084
19	4,117	4,149	4,181	4,214	4,246	4,279	4,312	4,345	4,378	4,411
20	4,444	4,478	4,511	4,545	4,579	4,612	4,646	4,680	4,715	4,749
21	4,783	4,818	4,852	4,887	4,922	4,957	4,992	5,027	5,062	5,098
22	5,133	5,169	5,205	5,240	5,276	5,312	5,349	5,385	5,421	5,458
23	5,494	5,531	5,568	5,605	5,642	5,679	5,716	5,754	5,791	5,829
24	5,867	5,904	5,942	5,980	6,018	6,057	6,095	6,134	6,172	6,212
25	6,250	6,289	6,328	6,367	6,406	6,446	6,485	6,525	6,565	6,604
26	6,644	6,684	6,725	6,765	6,805	6,846	6,886	6,927	6,968	7,009
27	7,050	7,091	7,132	7,174	7,215	7,257	7,299	7,340	7,382	7,424
28	7,467	7,509	7,551	7,594	7,636	7,679	7,722	7,765	7,808	7,851
29	7,894	7,938	7,981	8,025	8,069	8,112	8,156	8,200	8,245	8,289
30	8,333	8,378	8,422	8,467	8,512	8,557	8,602	8,647	8,692	8,738
31	8,783	8,829	8,875	8,920	8,966	9,012	9,059	9,105	9,151	9,198
32	9,244	9,291	9,338	9,385	9,432	9,479	9,526	9,574	9,621	9,669
33	9,717	9,764	9,812	9,860	9,909	9,957	10,005	10,054	10,102	10,151
34	10,200	10,249	10,298	10,347	10,396	10,446	10,495	10,545	10,595	10,644
35	10,694	10,744	10,795	10,845	10,895	10,946	10,996	11,047	11,098	11,149
36	11,200	11,251	11,302	11,354	11,405	11,457	11,507	11,560	11,612	11,664
37	11,717	11,769	11,821	11,874	11,926	11,979	12,032	12,085	12,138	12,191
38	12,244	12,298	12,351	12,404	12,459	12,512	12,566	12,620	12,675	12,729
39	12,783	12,838	12,892	12,947	13,002	13,057	13,112	13,167	13,222	13,278
40	13,333	13,389	13,445	13,500	13,556	13,612	13,669	13,725	13,781	13,838
41	13,894	13,951	14,008	14,065	14,122	14,179	14,236	14,294	14,351	14,409
42	14,467	14,524	14,582	14,640	14,699	14,757	14,815	14,874	14,932	14,991
43	15,050	15,109	15,168	15,227	15,286	15,346	15,405	15,465	15,525	15,584
44	15,644	15,704	15,765	15,825	15,885	15,946	16,006	16,067	16,128	16,189
45	16,250	16,311	16,372	16,434	16,495	16,557	16,619	16,681	16,742	16,805
46	16,867	16,928	16,991	17,054	17,116	17,179	17,242	17,305	17,368	17,431
47	17,494	17,558	17,621	17,685	17,749	17,813	17,876	17,941	18,005	18,069
48	18,133	18,198	18,262	18,327	18,392	18,457	18,522	18,587	18,652	18,718
49	18,783	18,849	18,915	18,980	19,046	19,113	19,179	19,245	19,311	19,378
50	19,444	19,511	19,578	19,645	19,712	19,779	19,846	19,914	19,981	20,049
51	20,117	20,185	20,252	20,321	20,389	20,457	20,525	20,594	20,662	20,731
52	20,800	20,869	20,938	21,007	21,076	21,146	21,215	21,285	21,355	21,425
53	21,494	21,565	21,635	21,705	21,775	21,846	21,916	21,987	22,058	22,129
54	22,200	22,271	22,342	22,414	22,485	22,557	22,629	22,701	22,772	22,845
55	22,917	22,989	23,061	23,134	23,206	23,279	23,352	23,425	23,498	23,571
56	23,644	23,718	23,791	23,865	23,939	24,013	24,086	24,161	24,235	24,309
57	24,383	24,458	24,532	24,607	24,682	24,757	24,832	24,907	24,982	25,058
58	25,133	25,209	25,285	25,361	25,436	25,513	25,589	25,665	25,741	25,818
59	25,894	25,971	26,048	26,125	26,202	26,279	26,356	26,434	26,511	26,589
60	26,667	26,745	26,822	26,901	26,979	27,057	27,135	27,214	27,292	27,371

TABLE No. XX.

SLOPE $1\frac{1}{2}$ TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 34 FEET.

Feet.	·0 c. yds.	·1 c. yds.	·2 c. yds.	·3 c. yds.	·4 c. yds.	·5 c. yds.	·6 c. yds.	·7 c. yds.	·8 c. yds.	·9 c. yds.
0	0	13	25	38	51	64	78	91	104	118
1	131	145	159	173	187	201	216	230	245	259
2	274	289	304	319	334	350	365	381	396	412
3	428	444	460	476	492	509	525	542	559	576
4	593	610	627	644	662	679	697	715	732	750
5	769	787	805	823	842	861	879	898	917	936
6	956	975	994	1,014	1,033	1,053	1,073	1,093	1,113	1,133
7	1,154	1,174	1,195	1,215	1,236	1,257	1,278	1,299	1,320	1,342
8	1,363	1,385	1,406	1,428	1,450	1,472	1,494	1,516	1,538	1,561
9	1,583	1,606	1,629	1,652	1,675	1,698	1,721	1,744	1,768	1,791
10	1,815	1,839	1,862	1,886	1,911	1,935	1,959	1,983	2,008	2,033
11	2,057	2,082	2,107	2,132	2,158	2,183	2,208	2,234	2,259	2,285
12	2,311	2,337	2,363	2,389	2,416	2,442	2,469	2,495	2,522	2,549
13	2,576	2,603	2,630	2,658	2,685	2,713	2,740	2,768	2,796	2,824
14	2,852	2,880	2,908	2,937	2,965	2,994	3,023	3,052	3,081	3,110
15	3,139	3,168	3,198	3,227	3,257	3,287	3,316	3,346	3,377	3,407
16	3,437	3,467	3,498	3,529	3,559	3,590	3,621	3,652	3,684	3,715
17	3,746	3,778	3,809	3,841	3,873	3,905	3,937	3,969	4,002	4,034
18	4,067	4,099	4,132	4,165	4,198	4,231	4,264	4,298	4,331	4,365
19	4,398	4,432	4,466	4,500	4,534	4,568	4,602	4,637	4,671	4,706
20	4,741	4,776	4,811	4,846	4,881	4,916	4,952	4,987	5,023	5,059
21	5,094	5,130	5,167	5,203	5,239	5,275	5,312	5,349	5,385	5,422
22	5,459	5,486	5,524	5,561	5,608	5,646	5,683	5,721	5,759	5,797
23	5,835	5,873	5,912	5,950	5,989	6,027	6,066	6,105	6,144	6,183
24	6,222	6,262	6,301	6,341	6,380	6,420	6,460	6,500	6,540	6,580
25	6,620	6,661	6,701	6,742	6,783	6,824	6,865	6,906	6,947	6,988
26	7,030	7,071	7,113	7,155	7,196	7,238	7,281	7,323	7,365	7,407
27	7,450	7,493	7,535	7,578	7,621	7,664	7,708	7,751	7,794	7,838
28	7,881	7,925	7,969	8,013	8,057	8,101	8,146	8,190	8,235	8,279
29	8,324	8,369	8,414	8,459	8,504	8,550	8,595	8,641	8,686	8,732
30	8,778	8,824	8,870	8,916	8,962	9,009	9,055	9,102	9,149	9,196
31	9,243	9,290	9,337	9,384	9,432	9,479	9,527	9,575	9,622	9,670
32	9,719	9,767	9,815	9,863	9,912	9,961	10,009	10,058	10,107	10,156
33	10,206	10,255	10,304	10,354	10,403	10,453	10,503	10,553	10,603	10,653
34	10,704	10,754	10,805	10,855	10,906	10,957	11,008	11,059	11,110	11,162
35	11,213	11,265	11,316	11,368	11,420	11,472	11,524	11,576	11,628	11,681
36	11,733	11,786	11,839	11,892	11,945	11,998	12,051	12,104	12,158	12,211
37	12,265	12,319	12,372	12,426	12,481	12,535	12,589	12,643	12,698	12,753
38	12,807	12,862	12,917	12,972	13,028	13,083	13,138	13,194	13,249	13,305
39	13,361	13,417	13,473	13,529	13,586	13,642	13,699	13,755	13,812	13,869
40	13,926	13,983	14,040	14,098	14,155	14,213	14,270	14,328	14,386	14,444
41	14,502	14,560	14,618	14,677	14,735	14,794	14,853	14,912	14,971	15,030
42	15,089	15,148	15,208	15,267	15,327	15,387	15,446	15,506	15,567	15,627
43	15,687	15,747	15,808	15,869	15,929	15,990	16,051	16,112	16,174	16,235
44	16,296	16,358	16,419	16,481	16,543	16,605	16,667	16,729	16,792	16,854
45	16,917	16,979	17,042	17,105	17,168	17,231	17,294	17,358	17,421	17,485
46	17,548	17,612	17,676	17,740	17,804	17,868	17,932	17,997	18,061	18,126
47	18,191	18,256	18,321	18,386	18,451	18,516	18,582	18,647	18,713	18,779
48	18,844	18,910	18,977	19,043	19,109	19,175	19,242	19,309	19,375	19,442
49	19,509	19,576	19,644	19,711	19,778	19,846	19,913	19,981	20,049	20,117
50	20,185	20,253	20,322	20,390	20,459	20,527	20,596	20,665	20,734	20,803
51	20,872	20,942	21,011	21,081	21,150	21,220	21,290	21,360	21,431	21,500
52	21,570	21,641	21,711	21,782	21,853	21,924	21,995	22,066	22,137	22,208
53	22,280	22,351	22,423	22,495	22,566	22,638	22,711	22,783	22,855	22,927
54	23,000	23,073	23,145	23,218	23,291	23,364	23,438	23,511	23,584	23,658
55	28,731	23,805	23,879	23,953	24,027	24,101	24,176	24,250	24,325	24,399
56	24,474	24,549	24,624	24,699	24,774	24,850	24,925	25,001	25,076	25,152
57	25,228	25,304	25,380	25,456	25,532	25,609	25,685	25,762	25,839	25,916
58	25.993	26,070	26,147	26,224	26,302	26,379	26,457	26,535	26,612	26,690
59	26,769	26,847	26,925	27,003	27,082	27,161	27,239	27,318	27,397	27,476
60	27,556	27,635	27,714	27,794	27,873	27,953	28,033	28,113	28,193	28,273

TABLE No. XXI.

SLOPE 1½ TO 1.

CORRECTION FOR DIFFERENCES OF DEPTHS.

Feet	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
ft.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.
1	0	1	1	1	1	1	1	1	2	2
2	2	2	2	2	3	3	3	3	4	4
3	4	4	5	5	5	6	6	6	7	7
4	7	8	8	9	9	9	10	10	11	11
5	12	12	13	13	14	14	15	15	16	16
6	17	17	18	18	19	20	20	21	21	22
7	23	23	24	25	25	26	27	27	28	29
8	30	30	31	32	33	33	34	35	36	37
9	37	38	39	40	41	42	43	44	44	45
10	46	47	48	49	50	51	52	53	54	55
11	56	57	58	59	60	61	62	63	64	66
12	67	68	69	70	71	72	74	75	76	77
13	78	79	81	82	83	84	86	87	88	89
14	91	92	93	95	96	97	99	100	101	103
15	104	106	107	108	110	111	113	114	116	117
16	119	120	122	123	125	126	128	129	131	132
17	134	135	137	139	140	142	143	145	147	148
18	150	152	153	155	157	158	160	162	164	165
19	167	169	171	172	174	176	178	180	181	183
20	185	187	189	191	193	195	196	198	200	202
21	204	206	208	210	212	214	216	218	220	222
22	224	226	228	230	232	234	236	239	241	243
23	245	247	249	251	253	256	258	260	262	264
24	267	269	271	273	276	278	280	282	285	287
25	289	292	294	296	299	301	303	306	308	311
26	313	315	318	320	323	325	328	330	333	335
27	337	340	343	345	348	350	353	355	358	360
28	363	366	368	371	373	376	379	381	384	387
29	389	392	395	397	400	403	406	408	411	414
30	417	419	422	425	428	431	433	436	439	442
31	445	448	451	453	456	459	462	465	468	471
32	474	477	480	483	486	489	492	495	498	501
33	504	507	510	513	516	519	523	526	529	532
34	535	538	542	545	548	551	554	557	561	564
35	567	570	574	577	580	583	587	590	593	597
36	600	603	607	610	614	617	620	624	627	630
37	634	637	641	644	648	651	654	658	661	665
38	668	692	675	679	683	686	690	693	697	701
39	704	708	711	715	719	722	726	730	733	737
40	741	744	748	752	756	759	763	767	771	774
41	778	782	786	790	693	797	801	805	809	813
42	817	821	824	828	832	836	840	844	848	852
43	856	860	864	868	872	876	880	884	888	892
44	896	900	904	908	913	917	921	925	929	933
45	938	942	946	850	954	958	963	967	971	975

TABLE No. XXII.

CONTENTS OF PRISMS WITH SQUARE BASES.

Feet.	·0 c. yds.	·1 c. yds.	·2 c. yds.	·3 c. yds.	·4 c. yds.	·5 c. yds.	·6 c. yds.	·7 c. yds.	·8 c. yds.	·9 c. yds.
0	0	0	0	0	1	1	1	2	2	3
1	4	4	5	6	7	8	9	11	12	13
2	15	16	18	20	21	23	25	27	29	31
3	33	36	38	40	43	45	48	51	53	56
4	59	62	65	68	72	75	78	82	85	89
5	93	96	100	104	108	112	116	120	125	129
6	133	138	142	147	152	156	161	166	171	176
7	181	187	192	197	203	208	214	220	225	231
8	237	243	249	255	261	268	274	280	287	293
9	300	307	313	320	327	334	341	348	356	363
10	370	378	385	393	401	408	416	424	432	440
11	448	456	465	473	481	490	398	507	516	524
12	533	542	551	560	569	579	588	597	607	616
13	626	636	645	655	665	675	685	695	705	716
14	726	736	747	757	768	779	789	800	811	822
15	833	844	856	867	878	890	901	913	925	936
16	948	960	972	984	996	1,008	1,021	1,033	1,045	1,058
17	1,070	1,083	1,096	1,108	1,121	1,134	1,147	1,160	1,173	1,187
18	1,200	1,213	1,227	1,240	1,254	1,268	1,281	1,295	1,309	1,323
19	1,337	1,351	1,365	1,380	1,394	1,408	1,423	1,437	1,452	1,467
20	1,481	1,496	1,511	1,526	1,541	1,556	1,572	1,587	1,602	1,618
21	1,633	1,649	1,665	1,680	1,696	1,712	1,728	1,744	1,760	1,776
22	1,792	1,809	1,825	1,842	1,858	1,875	1,892	1,908	1,925	1,942
23	1,959	1,976	1,993	2,011	2,028	2,045	2,063	2,080	2,098	2,116
24	2,133	2,151	2,169	2,187	2,205	2,223	2,241	2,260	2,278	2,296
25	2,315	2,333	2,352	2,371	2,389	2,408	2,427	2,446	2,465	2,484
26	2,504	2,523	2,542	2,562	2,581	2,601	2,621	2,640	2,660	2,680
27	2,700	2,720	2,740	2,760	2,781	2,801	2,821	2,842	2,862	2,883
28	2,904	2,924	2,945	2,966	2,987	3,008	3,029	3,051	3,072	3,093
29	3,115	3,136	3,158	3,180	3,201	3,223	3,245	3,267	3,289	3,311
30	3,333	3,356	3,378	3,400	3,423	3,445	3,468	3,491	3,513	3,536
31	3,559	3,582	3,605	3,628	3,652	3,675	3,698	3,722	3,745	3,769
32	3,793	3,816	3,840	3,864	3,888	3,912	3,936	3,960	3,985	4,009
33	4,033	4,058	4,082	4,107	4,132	4,156	4,181	4,206	4,231	4,256
34	4,281	4,307	4,332	4,357	4,383	4,408	4,434	4,460	4,485	4,511
35	4,537	4,563	4,589	4,615	4,641	4,668	4,694	4,720	4,747	4,773
36	4,800	4,827	4,853	4,880	4,907	4,934	4,961	4,988	5,016	5,043
37	5,070	5,098	5,125	5,153	5,181	5,508	5,236	5,264	5,292	5,320
38	5,348	5,376	5,405	5,433	5,461	5,490	5,518	5,547	5,576	5,604
39	5,633	5,662	5,691	5,720	5,749	5,779	5,808	5,837	5,867	5,896
40	5,926	5,956	5,985	6,015	6,045	6,075	6,105	6,135	6,165	6,196
41	6,226	6,256	6,287	6,317	6,348	6,379	6,409	6,440	6,471	6,502
42	6,533	6,564	6,596	6,627	6,658	6,690	6,721	6,753	6,785	6,816
43	6,848	6,880	6,912	6,944	6,976	7,008	7,041	7,073	7,105	7,138
44	7,170	7,203	7,236	7,268	7,301	7,334	7,367	7,400	7,433	7,467
45	7,500	7,533	7,567	7,600	7,634	7,668	7,701	7,735	7,769	7,803
46	7,837	7,871	7,905	7,940	7,974	8,008	8,043	8,077	8,112	8,147
47	8,181	8,216	8,251	8,286	8,321	8,356	8,392	8,427	8,462	8,498
48	8,533	8,569	8,605	8,640	8,676	8,712	8,748	8,784	8,820	8,856
49	8,893	8,829	8,965	9,002	9,038	9,075	9,112	9,148	9,185	9,222
50	9,259	9,296	9,333	9,371	9,408	9,445	9,483	9,520	9,558	9,596
51	9,633	9,671	9,709	9,747	9,785	9,823	9,861	9,900	9,938	9,976
52	10,015	10,053	10,092	10,131	10,169	10,208	10,247	10,286	10,325	10,364
53	10,404	10,443	10,482	10,522	10,561	10,601	10,641	10,680	10,720	10,760
54	10,800	10,840	10,880	10,920	10,961	11,001	11,041	11,082	11,122	11,163
55	11,204	11,244	11,285	11,326	11,367	11,408	11,449	11 491	11,532	11,573
56	11,615	11,656	11,698	11,740	11,781	11,823	11,865	11 907	11,949	11,991
57	12,033	12,076	12,118	12,160	12,203	12,245	12,288	12,331	12,374	12,416
58	12,459	12,502	12,545	12,588	12,632	12,675	12,718	12,762	12,805	12,849
59	12,893	12,936	12,970	13,014	13,068	13,112	13,156	13,200	13,245	13,289
60	13,333	13,378	13,422	13,467	13,512	13,556	13,601	13,646	13,691	13,736

TABLE No. XXI.

SLOPE 1½ TO 1.

CORRECTION FOR DIFFERENCES OF DEPTHS.

Feet	·0 c. yds.	·1 c. yds.	·2 c. yds.	·3 c. yds.	·4 c. yds.	·5 c. yds.	·6 c. yds.	·7 c. yds.	·8 c. yds.	·9 c. yds.
1	0	1	1	1	1	1	1	1	2	2
2	2	2	2	2	3	3	3	3	4	4
3	4	4	5	5	5	6	6	6	7	7
4	7	8	8	9	9	9	10	10	11	11
5	12	12	13	13	14	14	15	15	16	16
6	17	17	18	18	19	20	20	21	21	22
7	23	23	24	25	25	26	27	27	28	29
8	30	30	31	32	33	33	34	35	36	37
9	37	38	39	40	41	42	43	44	44	45
10	46	47	48	49	50	51	52	53	54	55
11	56	57	58	59	60	61	62	63	64	66
12	67	68	69	70	71	72	74	75	76	77
13	78	79	81	82	83	84	86	87	88	89
14	91	92	93	95	96	97	99	100	101	103
15	104	106	107	108	110	111	113	114	116	117
16	119	120	122	123	125	126	128	129	131	132
17	134	135	137	139	140	142	143	145	147	148
18	150	152	153	155	157	158	160	162	164	165
19	167	169	171	172	174	176	178	180	181	183
20	185	187	189	191	193	195	196	198	200	202
21	204	206	208	210	212	214	216	218	220	222
22	224	226	228	230	232	234	236	239	241	243
23	245	247	249	251	253	256	258	260	262	264
24	267	269	271	273	276	278	280	282	285	287
25	289	292	294	296	299	301	303	306	308	311
26	313	315	318	320	323	325	328	330	333	335
27	337	340	343	345	348	350	353	355	358	360
28	363	366	368	371	373	376	379	381	384	387
29	389	392	395	397	400	403	406	408	411	414
30	417	419	422	425	428	431	433	436	439	442
31	445	448	451	453	456	459	462	465	468	471
32	474	477	480	483	486	489	492	495	498	501
33	504	507	510	513	516	519	523	526	529	532
34	535	538	542	545	548	551	554	557	561	564
35	567	570	574	577	580	583	587	590	593	597
36	600	603	607	610	614	617	620	624	627	630
37	634	637	641	644	648	651	654	658	661	665
38	668	692	675	679	683	686	690	693	697	701
39	704	708	711	715	719	722	726	730	733	737
40	741	744	748	752	756	759	763	767	771	774
41	778	782	786	790	693	797	801	805	809	813
42	817	821	824	828	832	836	840	844	848	852
43	856	860	864	868	872	876	880	884	888	892
44	896	900	904	908	913	917	921	925	929	933
45	938	942	946	850	954	958	963	967	971	975

TABLE No. XXII.

CONTENTS OF PRISMS WITH SQUARE BASES.

Feet.	·0 c. yds.	·1 c. yds.	·2 c. yds.	·3 c. yds.	·4 c. yds.	·5 c. yds.	·6 c. yds.	·7 c. yds.	·8 c. yds.	·9 c. yds.
0	0	0	0	0	1	1	1	2	2	3
1	4	4	5	6	7	8	9	11	12	13
2	15	16	18	20	21	23	25	27	29	31
3	33	36	38	40	43	45	48	51	53	56
4	59	62	65	68	72	75	78	82	85	89
5	93	96	100	104	108	112	116	120	125	129
6	133	138	142	147	152	156	161	166	171	176
7	181	187	192	197	203	208	214	220	225	231
8	237	243	249	255	261	268	274	280	287	293
9	300	307	313	320	327	334	341	348	356	363
10	370	378	385	393	401	408	416	424	432	440
11	448	456	465	473	481	490	398	507	516	524
12	533	542	551	560	569	579	588	597	607	616
13	626	636	645	655	665	675	685	695	705	716
14	726	736	747	757	768	779	789	800	811	822
15	833	844	856	867	878	890	901	913	925	936
16	948	960	972	984	996	1,008	1,021	1,033	1,045	1,058
17	1,070	1,083	1,096	1,108	1,121	1,134	1,147	1,160	1,173	1,187
18	1,200	1,213	1,227	1,240	1,254	1,268	1,281	1,295	1,309	1,323
19	1,337	1,351	1,365	1,380	1,394	1,408	1,423	1,437	1,452	1,467
20	1,481	1,496	1,511	1,526	1,541	1,556	1,572	1,587	1,602	1,618
21	1,633	1,649	1,665	1,680	1,696	1,712	1,728	1,744	1,760	1,776
22	1,792	1,809	1,825	1,842	1,858	1,875	1,892	1,908	1,925	1,942
23	1,959	1,976	1,993	2,011	2,028	2,045	2,063	2,080	2,098	2,116
24	2,133	2,151	2,169	2,187	2,205	2,223	2,241	2,260	2,278	2,296
25	2,315	2,333	2,352	2,371	2,389	2,408	2,427	2,446	2,465	2,484
26	2,504	2,523	2,542	2,562	2,581	2,601	2,621	2,640	2,660	2,680
27	2,700	2,720	2,740	2,760	2,781	2,801	2,821	2,842	2,862	2,883
28	2,904	2,924	2,945	2,966	2,987	3,008	3,029	3,051	3,072	3,093
29	3,115	3,136	3,158	3,180	3,201	3,223	3,245	3,267	3,289	3,311
30	3,333	3,356	3,378	3,400	3,423	3,445	3,468	3,491	3,513	3,536
31	3,559	3,582	3,605	3,628	3,652	3,675	3,698	3,722	3,745	3,769
32	3,793	3,816	3,840	3,864	3,888	3,912	3,936	3,960	3,985	4,009
33	4,033	4,058	4,082	4,107	4,132	4,156	4,181	4,206	4,231	4,256
34	4,281	4,307	4,332	4,357	4,383	4,408	4,434	4,460	4,485	4,511
35	4,537	4,563	4,589	4,615	4,641	4,668	4,694	4,720	4,747	4,773
36	4,800	4,827	4,853	4,880	4,907	4,934	4,961	4,988	5,016	5,043
37	5,070	5,098	5,125	5,153	5,181	5,508	5,236	5,264	5,292	5,320
38	5,348	5,376	5,405	5,433	5,461	5,490	5,518	5,547	5,576	5,604
39	5,633	5,662	5,691	5,720	5,749	5,779	5,808	5,837	5,867	5,896
40	5,926	5,956	5,985	6,015	6,045	6,075	6,105	6,135	6,165	6,196
41	6,226	6,256	6,287	6,317	6,348	6,379	6,409	6,440	6,471	6,502
42	6,533	6,564	6,596	6,627	6,658	6,690	6,721	6,753	6,785	6,816
43	6,848	6,880	6,912	6,944	6,976	7,008	7,041	7,073	7,105	7,138
44	7,170	7,203	7,236	7,268	7,301	7,334	7,367	7,400	7,433	7,467
45	7,500	7,533	7,567	7,600	7,634	7,668	7,701	7,735	7,769	7,803
46	7,837	7,871	7,905	7,940	7,974	8,008	8,043	8,077	8,112	8,147
47	8,181	8,216	8,251	8,286	8,321	8,356	8,392	8,427	8,462	8,498
48	8,533	8,569	8,605	8,640	8,676	8,712	8,748	8,784	8,820	8,856
49	8,893	8,829	8,965	9,002	9,038	9,075	9,112	9,148	9,185	9,222
50	9,259	9,296	9,333	9,371	9,408	9,445	9,483	9,520	9,558	9,596
51	9,633	9,671	9,709	9,747	9,785	9,823	9,861	9,900	9,938	9,976
52	10,015	10,053	10,092	10,131	10,169	10,208	10,247	10,286	10,325	10,364
53	10,404	10,443	10,482	10,522	10,561	10,601	10,641	10,680	10,720	10,760
54	10,800	10,840	10,880	10,920	10,961	11,001	11,041	11,082	11,122	11,163
55	11,204	11,244	11,285	11,326	11,367	11,408	11,449	11 491	11,532	11,573
56	11,615	11,656	11,698	11,740	11,781	11,823	11,865	11 907	11,949	11,991
57	12,033	12,076	12,118	12,160	12,203	12,245	12,288	12,331	12,374	12,416
58	12,459	12,502	12,545	12,588	12,632	12,675	12,718	12,762	12,805	12,849
59	12,893	12,936	12,970	13,014	13,068	13,112	13,156	13,200	13,245	13,289
60	13,333	13,378	13,422	13,467	13,512	13,556	13,601	13,646	13,691	13,736

TABLE No. XXII.

(CONTINUED.)

CONTENTS OF PRISMS WITH SQUARE BASES.

Feet.	·0 c. yds.	·1 c. yds.	·2 c. yds.	·3 c. yds.	·4 c. yds.	·5 c. yds.	·6 c. yds.	·7 c. yds.	·8 c. yds.	9. c. yds.
183	124,033	124,169	124,305	124,404	124,576	124,712	124,848	124,984	125,120	125,256
184	124,393	125,529	125,665	125,802	125,938	126,075	126,212	126,348	126,485	126,622
186	126,759	126,896	127,033	127,171	127,308	127,445	127,583	127,720	127,858	127,996
186	128,133	128,271	128,409	128,447	128,686	128,823	128,961	129,100	129,238	129,373
187	129,515	129,653	129,792	129,931	130,069	130,208	130,347	130,486	130,625	130,764
188	130,904	131,043	131,182	131,322	131,461	131,601	131,741	131,880	132,020	132,160
189	132,300	132,440	132,580	132,720	132,861	133,001	133,141	133,282	133,422	133,563
190	133,704	133,844	133,985	134,126	134,267	134,408	134,549	134,691	134,832	134,973
191	135,115	135,256	135,398	135,540	135,681	135,823	135,965	136,107	136,249	136,391
192	136,533	136,676	136,818	136,960	137,103	137,245	137,388	137,531	137,673	137,816
193	137,959	138,102	138,246	138,388	138,532	138,675	138,818	138,962	139,105	139,249
194	139,393	139,536	139,680	139,824	139,968	140,112	140,256	140,400	140,545	140,689
195	140,833	140,978	141,122	141,267	141,412	141,556	141,701	141,846	141,991	142,136
196	142,281	142,427	142,572	142,717	142,823	143,008	143,154	143,300	143,445	143,591
197	143,737	143,883	144,029	144,175	144,321	144,468	144,614	144,760	144,907	145,053
198	145,200	145,347	145,493	145,640	145,787	145,934	146,081	146,228	146,376	146,523
199	146,670	146,818	146,965	147,113	147,261	147,408	147,556	147,704	147,852	148,000
200	148,148	148,296	148,445	148,593	148,741	148,890	149,038	149,187	149,336	149,484

TABLE No. XXIII.

SLOPE ½ TO 1.

Degrees.	Greater and lesser areas. A	½ Dif.	a	½ Dif.	A−a	½ Dif.	Greater and lesser Horizontal distances. Y	½ Dif.	y	½ Dif.	Y+y	½ Dif.	Side distances. Greater.	Lesser.
1	·0022	11	·0022	10	·0000	1	·5044	23	·4957	22	1·0001	1	·505	·496
2	·0044	12	·0043	11	·0002	1	·5089	23	·4914	21	1·0003	2	·509	·492
3	·0067	12	·0064	10	·0004	1	·5135	23	·4872	20	1·0007	3	·514	·488
4	·0091	12	·0085	10	·0006	2	·5181	24	·4831	20	1·0012	4	·519	·484
5	·0114	12	·0105	10	·0010	2	·5229	24	·4790	20	1·0019	5	·525	·481
6	·0139	12	·0125	10	·0014	3	·5277	25	·4750	19	1·0027	6	·531	·478
7	·0164	13	·0145	10	·0019	3	·5327	26	·4711	19	1·0038	6	·537	·475
8	·0189	13	·0164	10	·0025	3	·5378	26	·4672	19	1·0050	7	·543	·472
9	·0215	13	·0184	10	·0032	4	·5430	27	·4633	19	1·0063	8	·550	·469
10	·0242	14	·0203	10	·0039	4	·5484	27	·4595	19	1·0079	9	·557	·467
11	·0269	14	·0222	9	·0048	5	·5538	28	·4557	18	1·0095	10	·564	·464
12	·0297	15	·0240	9	·0057	5	·5595	29	·4520	18	1·0115	11	·572	·462
13	·0326	15	·0259	9	·0068	6	·5653	30	·4483	18	1·0136	12	·580	·460
14	·0356	15	·0277	9	·0079	6	·5712	31	·4446	18	1·0158	13	·589	·458
15	·0387	16	·0295	9	·0091	7	·5774	32	·4409	18	1·0183	14	·597	·457
16	·0418	16	·0314	9	·0105	7	·5837	33	·4373	18	1·0210	15	·607	·455
17	·0451	17	·0332	9	·0120	8	·5902	34	·4337	18	1·0239	16	·617	·454
18	·0485	18	·0349	9	·0136	9	·5970	35	·4301	18	1·0271	18	·628	·452
19	·0520	18	·0367	9	·0153	9	·6040	36	·4266	18	1·0306	18	·639	·451
20	·0556	19	·0385	9	·0171	10	·6112	37	·4230	17	1·0342	20	·651	·450
21	·0594	20	·0403	9	·0191	11	·6188	39	·4195	17	1·0383	22	·663	·449
22	·0633	20	·0420	9	·0213	12	·6266	41	·4160	17	1·0426	23	·676	·449
23	·0674	21	·0438	9	·0236	12	·6347	43	·4125	17	1·0472	25	·690	·448
24	·0716	22	·0455	9	·0261	13	·6432	44	·4090	17	1·0522	27	·704	·448
25	·0760	23	·0473	9	·0287	14	·6520	47	·4055	17	1·0575	29	·720	·447
26	·0806	24	·0490	9	·0316	16	·6613	48	·4020	17	1·0633	31	·736	·447
27	·0855	25	·0508	9	·0347	17	·6709	51	·3985	17	1·0694	34	·753	·447
28	·0905	27	·0525	9	·0380	18	·6811	53	·3950	17	1·0761	36	·771	·447
29	·0959	28	·0543	9	·0416	19	·6917	56	·3915	17	1·0832	39	·791	·448
30	·1015	30	·0560	9	·0455	21	·7029	59	·3880	17	1·0909	42	·812	·448
31	·1074	31	·0578	9	·0496	22	·7147	63	·3845	17	1·0992	45	·834	·449
32	·1136	33	·0595	9	·0541	24	·7272	66	·3810	18	1·1082	48	·858	·449
33	·1202	35	·0613	9	·0589	26	·7404	71	·3774	18	1·1178	53	·883	·450
34	·1272	37	·0631	9	·0642	28	·7545	75	·3739	18	1·1284	57	·910	·451
35	·1347	40	·0648	9	·0699	31	·7694	80	·3703	18	1·1397	62	·939	·452
36	·1426	43	·0666	9	·0760	34	·7853	85	·3668	18	1·1521	67	·971	·453
37	·1512	46	·0684	9	·0827	37	·8023	91	·3632	18	1·1655	73	1·005	·455
38	·1603	49	·0702	9	·0901	40	·8205	99	·3595	18	1·1800	81	1·041	·456
39	·1701	53	·0721	9	·0981	44	·8402	106	·3559	18	1·1961	88	1·081	·458
40	·1807	58	·0739	9	·1068	48	·8614	115	·3522	18	1·2136	97	1·125	·460
41	·1922	63	·0757	9	·1165	53	·8844	125	·3485	18	1·2329	107	1·172	·462
42	·2047	68	·0776	10	·1271	59	·9094	137	·3448	19	1·2542	118	1·224	·464
43	·2184	75	·0795	10	·1389	66	·9368	150	·3410	19	1·2778	131	1·281	·466
44	·2334	83	·0814	10	·1520	73	·9668	166	·3372	19	1·3040	147	1·344	·469
45	·2500	92	·0833	10	·1667	82	1·0000	184	·3333	19	1·3333	165	1·414	·471
46	·2684	103	·0853	10	·1832	93	1·0368	206	·3294	19	1·3662	187	1·493	·474
47	·2890	116	·0873	10	·2018	106	1·0780	232	·3255	19	1·4035	217	1·581	·477
48	·3122	132	·0893	10	·2230	121	1·1244	263	·3215	19	1·4459	243	1·681	·481
49	·3385		·0913		·2472		1·1770		·3174		1·4944		1·794	·484

TABLE No. XXIV.

SLOPE 1 TO 1.

Degrees.	Greater and lesser areas. A	½ Dif.	a	½ D.	A—a	½ Dif.	Greater and lesser Horizontal distances. Y	½ Dif.	y	½ D.	Y+y	½ Dif.	Side distances. Greater.	Lesser.
1	·0089	46	·0086	41	·0003	5	1·0178	92	·9828	83	2·0006	10	1·018	·983
2	·0181	48	·0169	40	·0012	8	1·0362	96	·9663	80	2·0025	15	1·037	·967
3	·0277	50	·0249	39	·0028	11	1·0553	99	·9502	78	2·0055	22	1·057	·952
4	·0376	52	·0327	38	·0049	14	1·0752	104	·9346	75	2·0098	28	1·078	·937
5	·0479	54	·0402	37	·0077	17	1·0959	108	·9196	73	2·0154	35	1·100	·923
6	·0587	56	·0476	36	·0112	21	1·1175	113	·9049	71	2·0223	42	1·124	·910
7	·0700	59	·0547	35	·0153	24	1·1400	118	·8907	69	2·0306	49	1·149	·897
8	·0818	62	·0616	34	·0202	28	1·1635	123	·8768	68	2·0403	56	1·175	·885
9	·0941	65	·0684	33	·0257	32	1·1882	129	·8633	66	2·0515	64	1·203	·874
10	·1070	68	·0750	32	·0321	36	1·2141	136	·8501	64	2·0642	72	1·233	·863
11	·1206	72	·0814	31	·0393	40	1·2413	143	·8373	63	2·0785	81	1·264	·853
12	·1350	76	·0877	31	·0473	45	1·2699	151	·8247	61	2·0946	90	1·298	·843
13	·1501	80	·0938	30	·0563	50	1·3002	160	·8124	60	2·1126	100	1·334	·834
14	·1661	85	·0998	29	·0663	55	1·3321	169	·8004	59	2·1326	111	1·373	·825
15	·1830	90	·1057	29	·0774	61	1·3660	180	·7887	58	2·1547	123	1·414	·816
16	·2010	96	·1114	28	·0896	68	1·4020	192	·7772	57	2·1792	135	1·459	·808
17	·2202	102	·1171	28	·1031	75	1·4404	205	·7659	55	2·2062	150	1·506	·801
18	·2407	110	·1226	27	·1180	82	1·4813	219	·7548	54	2·2361	165	1·558	·794
19	·2626	118	·1281	27	·1345	91	1·5252	236	·7439	54	2·2690	182	1·613	·787
20	·2861	127	·1334	26	·1527	101	1·5723	254	·7332	53	2·3054	201	1·673	·780
21	·3115	137	·1387	26	·1728	111	1·6230	275	·7226	52	2·3456	223	1·738	·774
22	·3390	149	·1439	26	·1951	123	1·6779	298	·7122	51	2·3902	247	1·810	·768
23	·3686	163	·1490	25	·2198	137	1·7375	325	·7020	50	2·4396	275	1·888	·762
24	·4013	178	·1540	25	·2472	153	1·8025	356	·6919	50	2·4945	306	1·973	·757
25	·4369	196	·1590	25	·2779	171	1·8737	392	·6820	49	2·5557	343	2·067	·752
26	·4761	217	·1639	24	·3121	193	1·9521	434	·6722	49	2·6243	385	2·172	·748
27	·5194	242	·1688	24	·3507	218	2·0388	483	·6625	48	2·7013	435	2·288	·743
28	·5677	271	·1736	24	·3942	247	2·1354	541	·6529	47	2·7883	494	2·418	·739
29	·6219	306	·1783	24	·4435	282	2·2437	612	·6434	47	2·8871	565	2·566	·736
30	·6830	348	·1830	23	·5000	325	2·3660	697	·6340	47	3·0000	651	2·732	·732
31	·7527	401	·1877	23	·5650	378	2·5051	802	·6247	46	3·1301	756	2·923	·729
32	·8329	467	·1923	23	·6406	444	2·6657	933	·6154	46	3·2812	887	3·143	·726
33	·9262	550	·1969	23	·7293	527	2·8523	1100	·6063	45	3·4586	·1055	3·401	·723
34	1·0361	659	·2014	23	·8347	636	3·0723	1317	·5972	45	3·6695	·1272	3·705	·720
35	1·1679	803	·2059	22	·9619	781	3·3357	1606	·5882	45	3·9239	·1561	4·072	·718
36	1·3284	·1002	·2104	22	1·1180	980	3·6569	2004	·5792	45	4·2361	·1960	4·520	·716
37	1·5289	·1286	·2149	22	1·3140	·1264	4·0577	2572	·5703	44	4·6280	·2528	5·081	·714
38	1·7861	·1713	·2193	22	1·5668	·1690	4·5722	3425	·5614	44	5·1336	·3381	5·802	·712
39	2·1286	·2395	·2237	22	1·9049	·2373	5·2572	4789	·5526	44	5·8097	·4746	5·765	·711
40	2·6075	·3588	·2281	22	2·3794	·3566	6·2150	7176	·5437	44	6·7588	·7133	8·113	·710
41	3·3252	·5976	·2325	22	3·0927	·5954	7·6503	1·1951	·5350	44	8·1853	1·1908	10·137	·709
42	4·5203	1·1944	·2369	22	4·2834	1·1922	10·0406	2·3888	·5262	44	10·5668	2·3844	13·511	·708
43	6·9091	3·5817	·2413	22	6·6678	3·5795	14·8181	7·1634	·5175	44	15·3356	7·1591	20·261	·708
44	14·0725		·2456	22	13·8269		29·1450		·5087	44	29·6537		40·516	·707
45	infinite.		·2500				infinite.		·5000		infinite.		infin.	·707

TABLE No. XXV.

SLOPE 1½ TO 1.

Degrees.	Greater and lesser areas. A	½ Dif.	a	½ Dif.	A—a	½ Dif.	Greater and lesser Horizontal distances. Y	½ Dif.	y	½ Dif.	Y+y	½ Dif.	Side distances. Greater.	Lesser.	Degrees.
1	·0202	107	·0191	91	·0011	15	1·5403	213	1·4617	182	3·0020	31	1·541	1·463	1
2	·0415	113	·0373	87	·0041	26	1·5829	225	1·4263	173	3·0082	52	1·584	1·427	2
3	·0640	119	·0547	83	·0093	37	1·6280	239	1·3907	165	3·0187	74	1·631	1·392	3
4	·0879	127	·0712	79	·0167	48	1·6758	254	1·3576	158	3·0334	96	1·680	1·361	4
5	·1133	135	·0870	76	·0263	60	1·7267	271	1·3260	151	3·0527	121	1·733	1·331	5
6	·1404	145	·1021	73	·0382	72	1·7808	290	1·2957	145	3·0765	145	1·791	1·304	6
7	·1693	155	·1167	70	·0527	86	1·8387	310	1·2667	139	3·1055	172	1·853	1·277	7
8	·2004	167	·1306	67	·0698	100	1·9008	334	1·2388	134	3·1396	200	1·920	1·251	8
9	·2337	180	·1439	65	·0898	115	1·9676	360	1·2120	129	3·1796	231	1·992	1·227	9
10	·2697	195	·1569	62	·1129	133	2·0396	390	1·1862	124	3·2258	266	2·072	1·205	10
11	·3087	212	·1693	60	·1394	152	2·1176	424	1·1613	120	3·2789	304	2·157	1·184	11
12	·3511	231	·1813	58	·1698	173	2·2024	463	1·1373	116	3·3397	347	2·252	1·163	12
13	·3974	254	·1929	56	·2045	198	2·2950	508	1·1141	112	3·4091	395	2·355	1·143	13
14	·4482	280	·2041	54	·2440	225	2·3965	560	1·0916	109	3·4881	452	2·471	1·125	14
15	·5041	310	·2150	53	·2891	258	2·5085	621	1·0699	106	3·5784	515	2·597	1·107	15
16	·5662	346	·2256	51	·3406	295	2·6326	693	1·0488	102	3·6814	591	2·739	1·091	16
17	·6354	389	·2358	50	·3996	339	2·7712	778	1·0283	100	3·7995	679	2·898	1·076	17
18	·7132	441	·2457	48	·4675	392	2·9269	882	1·0084	97	3·9353	785	3·078	1·061	18
19	·8014	504	·2554	47	·5460	457	3·1032	·1007	·9890	94	4·0922	911	3·282	1·046	19
20	·9021	581	·2648	46	·6373	535	3·3047	·1163	·9702	92	4·2749	·1071	3·516	1·032	20
21	1·0183	679	·2740	45	·7443	635	3·5373	·1359	·9518	90	4·4891	·1269	3·789	1·020	21
22	1·1542	804	·2830	44	·8712	761	3·8090	·1609	·9339	88	4·7429	·1522	4·109	1·008	22
23	1·3151	968	·2917	43	1·0233	926	4·1308	·1937	·9164	85	5·0472	·1853	4·488	·996	23
24	1·5087	·1189	·3003	42	1·2085	·1147	4·5183	·2379	·8994	84	5·4177	·2294	4·946	·984	24
25	1·7466	·1496	·3087	41	1·4379	·1455	4·9940	·2993	·8825	82	5·8765	·2911	5·510	·974	25
26	2·0458	·1941	·3168	40	1·7289	·1901	5·5925	·3882	·8662	80	6·4587	·3802	6·222	·964	26
27	2·4339	·2620	·3249	39	2·1090	·2581	6·3690	·5241	·8501	79	7·2191	·5163	7·148	·954	27
28	2·9578	·3735	·3327	39	2·6251	·3696	7·4172	·7471	·8344	77	8·2516	·7394	8·401	·945	28
29	3·7047	·5757	·3405	38	3·3648	·5719	8·9114	1·1516	·8189	76	9·7303	1·1441	10·189	·936	29
30	4·8561	1·0040	·3480	37	4·5080	1·0003	11·2146	2·0085	·8038	75	12·0184	2·0010	12·950	·928	30
31	6·8641	2·1957	·3555	37	6·5086	2·1920	15·2316	4·3924	·7888	73	16·0204	4·3851	17·769	·920	31
32	11·2554	8·6190	·3628	36	10·8925	8·6154	24·0164	17·2424	·7742	72	24·7906	17·2352	28·320	·913	32
33	28·4933		·3700		28·1233		58·5019		·7597		59·2609		69·755	·906	33

TABLE No. XXVI.

SLOPE 2 TO 1.

Degrees.	Greater and lesser areas. A	½ Dif.	a	½ Dif.	A—a	½ Dif.	Greater and lesser Horizontal distances. Y	½ Dif.	y	½ Dif.	Y+y	½ Dif.	Side distances. Greater.	Lesser.	Degrees.
1	·0362	195	·0337	158	·0025	37	2·0723	390	1·9325	315	4·0048	74	2·073	1·933	1
2	·0751	210	·0653	148	·0098	62	2·1502	420	1·8694	295	4·0196	125	2·151	1·870	2
3	·1171	228	·0949	139	·0222	89	2·2342	455	1·8103	277	4·0445	177	2·237	1·813	3
4	·1626	248	·1227	131	·0399	117	2·3252	495	1·7546	262	4·0798	233	2·331	1·759	4
5	·2121	270	·1489	124	·0632	146	2·4241	541	1·7022	248	4·1263	293	2·433	1·709	5
6	·2661	297	·1737	118	·0924	180	2·5323	594	1·6526	235	4·1849	359	2·546	1·662	6
7	·3255	328	·1972	111	·1283	217	2·6510	655	1·6057	222	4·2567	432	2·671	1·618	7
8	·3910	363	·2194	106	·1716	257	2·7819	727	1·5612	211	4·3431	515	2·809	1·577	8
9	·4636	406	·2406	101	·2230	305	2·9272	811	1·5189	201	4·4461	610	2·964	1·538	9
10	·5447	456	·2607	96	·2840	361	3·0894	913	1·4786	192	4·5680	720	3·137	1·501	10
11	·6360	517	·2799	92	·3561	425	3·2719	·1035	1·4401	183	4·7120	851	3·333	1·467	11
12	·7394	592	·2983	88	·4411	504	3·4788	·1183	1·4034	175	4·8822	·1008	3·556	1·435	12
13	·8577	684	·3159	84	·5418	600	3·7154	·1368	1·3683	168	5·0837	·1200	3·813	1·404	13
14	·9945	800	·3327	81	·6618	719	3·9890	·1600	1·3346	162	5·3236	·1438	4·111	1·375	14
15	1·1545	950	·3489	78	·8056	872	4·3090	·1899	1·3022	155	5·6112	·1744	4·461	1·348	15
16	1·3444	·1146	·3645	75	·9799	·1071	4·6888	·2291	1·2711	150	5·9599	·2141	4·878	1·322	16
17	1·5735	·1410	·3794	73	1·1941	·1338	5·1470	·2820	1·2411	144	6·3881	·2676	5·382	1·298	17
18	1·8555	·1780	·3939	70	1·4616	·1710	5·7110	·3559	1·2123	139	6·9233	·3420	6·005	1·275	18
19	2·2114	·2318	·4078	68	1·8036	·2251	6·4228	·4636	1·1844	134	7·6072	·4502	6·792	1·253	19
20	2·6750	·3147	·4213	65	2·2537	·3082	7·3500	·6294	1·1575	130	8·5075	·6163	7·821	1·232	20
21	3·3043	·4520	·4343	63	2·8700	·4457	8·6087	·9039	1·1314	126	9·7401	·8913	9·221	1·212	21
22	4·2083	·7048	·4469	61	3·7614	·6987	10·4165	1·4095	1·1062	122	11·5227	1·3973	11·234	1·193	22
23	5·6178	1·2530	·4591	60	5·1587	1·2470	13·2355	2·5060	1·0817	118	14·3172	2·4942	14·378	1·175	23
24	8·1237	2·8511	·4710	58	7·6527	2·8453	18·2475	5·7021	1·0580	115	19·3055	5·6906	19·973	1·158	24
25	13·8259	12·9096	·4826	56	13·3433	12·9040	29·6517	25·8192	1·0349	112	30·6866	25·8079	32·715	1·142	25
26	39·6450		·4938		39·1512		81·2900		1·0124		82·3024		90·437	1·126	26

REPORT OF THE PHILADELPHIA AND READING RAILROAD COMPANY.

To the Stockholders of the Philadelphia and Reading Railroad Company.

The finances of the company at the commencement of the last year were in a state of great embarrassment.

The first object of the managers was to raise a moderate sum of money, on a temporary loan, to discharge a per centage of the pressing claims on the company, and to pay cash for expenses and further construction. This was done. The credit of the company was sensibly improved, and large reductions were made in the prices of wages, and of materials used on the road.

Owing to the fact that the shipments of coal had usually been discontinued about the 1st of December, and not resumed until about the 1st of April following, the quantity of coal transported in the months of January and February was small. In March a material improvement took place, and in April the trade was only limited by the engines and cars, want of additional track and turnouts, and the wharf accommodation then possessed by the company.

To provide these additional facilities for the increasing transportation, to repay the temporary loan, and to continue the gradual discharge of pressing claims on the company, a loan to the amount of $500,000 was obtained in May last, on an issue of bonds secured by a mortgage, as authorized by the stockholders 10th of June, 1836.

In July, owing to the additional machinery on the road, and the greater efficiency of the track and wharves, the coal traffic was still further increased, and since then has been rapidly enlarged, as the annexed statement of transportation receipts will show.

Accompanying this is a report of the superintendant of transportation, giving statements of the various expenditures in his department; and also a report of the engineer of the road, of the expense of repairs of track, bridges, etc., and its present good condition, both of which exhibit a very satisfactory state of efficiency of the road and of its moving power.

The experience of last year's operation on the road having so entirely confirmed the opinion of the importance of an entire double track, and an extension of the wharves at Richmond, a successful effort has been made to accomplish this object by the negotiation of a loan to raise the sum of one million of dollars, for which the managers have agreed to give the bonds of the company, secured by a new mortgage, to be made payable in 1860; interest at six per cent. per annum, and convertible into stock at the option of the holder. Measures have been taken to complete the work at the earliest possible period. When this is done, and an additional number of cars and engines, which are also to be provided, are placed on the road, this great work will be powerfully effective and capable of doing a largely increased business: and it gives me pleasure to add, that I have found a strong desire among the dealers in coal, produce and merchandize, to avail themselves of the use of the road, if extended facilities are given them for transportation.

In the month of March last, a temporary mortgage as collateral security, was executed to cover the amount of $212,635, which will be due in June, 1845, for the 450 coal cars and 12 locomotive engines furnished.

When the loan of May last was agreed on, it was deemed expedient and proper by the managers to increase that mortgage to an amount which would raise such further means as might be required to settle or pay off still more of the floating debt, and enable the company to make such further improvements on the road as were needed; accordingly, the mortgage was executed to cover the issue of two hundred and twenty-five thousand pounds sterling

bonds, and six hundred thousand dollars of dollar bonds, payable in 1860, with interest at six per cent., and convertible into stock at the option of the holder. Of these, there has been issued for sales and as collaterals,

Of sterling bonds,	£157,000
Of dollar bonds,	$251,500

leaving now on hand, in possession of the treasurer, £68,000 of sterling bonds, and $348,500 of dollar bonds, for any purposes which may be required.

I submit herewith a statement of the liabilities of the company made by S. Bradford, Esq., secretary and treasurer, which, having increased materially over that of last year, calls for the following explanations.

The critical position of the company in 1842, and the unfinished state of the road, obliged the managers then to raise money at great sacrifices, for which bonds have been issued the past year, according to their agreement.

The improvements on the road, and general extension of its capacity and moving power, which has been going on through the whole of the past year, have necessarily materially increased the items of "construction account," and "locomotive engines and cars."

The still large amount of "notes payable," notwithstanding the very considerable sum paid this year in cash, is accounted for by a large portion of the judgments represented in last year's ballance sheet and part of the loan due in 1843, being this year merged into "notes payable," and by numerous settlements with contractors, and for land damages, etc., which, till this year, it has not been in the power of the company to make an adjustment of, now largely reduced.

The "bonds and mortgages on real estate" existed previous to the last year. To represent the true cost of this property, the amount is now charged on "real estate" account.

The "drafts payable" have been reduced from $102,170, on December 1, 1842, to $26,955, December 1, 1843, which will soon be liquidated.

I have to state that a settlement was effected in April last of the large debt to the trustees of the bank of the United States, at a gain to the company, of $75,000.

The officers and agents of the company in their respective departments, have fulfilled their duties in a manner which has been gratifying to me, and I trust that the general management of this important work the past year, during which it has been raised from a position of great depression, to its present effective state, will meet the approval of those interested in it.

Very respectfully,

January 3, 1844. John Cryder, *President.*

To the President and Board of Managers of the Philadelphia and Reading Railroad Company.

Gentlemen—The following report of the operations on the road, during the eleven months ending November, 30th, of the present year, of its business and its machinery, is respectfully submitted.

The business of the road in its most important feature, the transportation of coal, has been almost wholly dependant upon, and proportioned to, the increase of track facilities, and of machinery, engines and cars, furnished for that purpose, during the present year.

In the last report of the general superintendant, of December 31st, 1842, there were on the road, at that date, 1130 coal cars, and 16 coal engines; these numbers have been increased to 1502 coal cars, during the months of May and June of this year, and to 30 locomotive engines, adapted to hauling coal, between the months of June and September, 1843.

Statement A will show in detail the force of machinery at present on the road.

The quantity of coal hauled over the road to June 30th, before the machinery had been increased to its present force, and the track and wharves made more effective, amounted to 62,099 tons; since which time, to the present date, a period of five months, the coal tonnage has risen to 156,612 tons, making a total of 218,711 tons of coal transported to market during the eleven calender months ending November 30th, 1843.

The efficiency of the road in passing, with expedition and safety, coal, freight and passenger trains, moving in opposite directions, has been very materially increased by the completion, in July last, of 10 miles of double track, extending from Baumstown to one mile above Reading.

Statement C exhibits in detail the expenses of the transportation department of the road, and statement D, the apportionment of these expenses to the several items of business on the road—coal, freight and passengers.

It will be observed, from the latter statement, that the actual cost of hauling coal from the mines to the Delaware, including returning the empty cars has been, during the year, but 46 cents per ton. This has been much higher than may be calculated on for the future, for the following reasons:

1st. The inferior quality of construction of most of the coal cars built for the company, owing, in a great measure, to the haste with which they were constructed, causing an unnecessary frequency of accident from breaking axles, etc., and a serious increase in their repairs.

2d. The comparatively small and uncertain business done in the early part of the year, which consequently increased the cost of carriage per ton, from engines failing to obtain trains from either end of the line, and running in some cases with loads below their allotted compliments.

3d. From the expense, direct and indirect, attending the employment of 12 new engines, built by the Locks and Canals Co., each of these being placed in the heavy business of the road, immediately on being put together, and, on several occasions, failing when on duty, from defective arrangements, and quality of some of the lighter gearing.

4th. From the short period, (the last three months only,) during which there has been employed a new system of working the road, by which the maximum effect of all its machinery and track facilities was obtained, with an evident economy resulting.

5th. The greater proportion of light six wheeled engines, in the first six months of the year, compared with the whole number in the latter part; the former hauling lighter trains, and consequently increasing the cost per ton of coal.

Lastly. The greater experience gained by the year's working of the road and its machinery, pointing out where improvements or alterations may be made with advantage and economy, in either the general features or minute details of the important work under your direction.

From the above considerations, it is confidently believed that the cost of hauling coal per ton, during the ensuing year, 1844, will not exceed 40 cents.

On a comparison, it is found that the receipts from passengers for the present year, amount to but 77 per cent. of those of 1842. This falling off, however, has been materially checked by a reduction of the rates of fare, which took place on July 24th last, since which date the receipts have increased to 89 per cent. of the same period last year; having been previous to that date only 69 per cent. of the receipts of that year.

The passenger fares now charged are \$2 50 and \$2 00 for the 93 miles.

A still greater increase of passenger travel and receipts may be confidently anticipated during the ensuing year, and for the future, when the low rates of fare now charged shall have become more extensively known and circulated.

Alterations are now making on some of the light four wheeled passenger engines, which will increase their speed by some three or four miles an hour at a trifling expense; which, when effected, will allow a more favorable comparison with other well constructed roads in speed of passenger trains—an important object to this road.

It may be stated, as a gratifying fact, that notwithstanding the very heavy amount of tonnage passed over the road during the past eleven months, 56,554 passengers have been transported without the slightest personal injury to any one.

By reference to statement A, it will be seen that the company own at present 39 locomotive engines, built by the following makers:

8	passenger and light freight engines, made by	Braithwait & Millner, London.
12	coal engines, made by	Locks and Canals Co., Lowell.
3	" "	Eastwick & Harrison, Philadelphia.
2	" "	Wm. Norris, Philadelphia.
5	" "	Newcastle Manufacturing Co., Newcastle, Del.
2	" "	Dotterer & Co., Reading, Pa.
6	light " "	M. W. Baldwin, Philadelphia.
1	four wheeled with vertical boiler to burn coal, made by	Ross Winans, Baltimore.
39		

All of which are at this date in good running order, or undergoing such light repairs as to be ready for service on the road at two days notice, with the exception of one of the new engines, now altering with a view of fully testing the use of anthracite coal for fuel.

Convenience and economy will both render the successful result of this experiment most desirable, although several previous attempts to burn this fuel with advantage have been attended with an expense and inconvenience which, in some cases, deranged the business of the road.

The undersigned is aware of the importance of introducing this fuel upon a road which depends mainly upon the coal trade and the coal region for its support; but has been unwilling to expose the road, while working smoothly and passing a heavy business over its single track, to that inconvenience which has hitherto in most cases, on this as well as other roads, attended such experiments.

It is hoped and believed that the attempt will eventually succeed, and all that skill, experience and ingenuity can suggest, will be done to effect this most desirable object.

The tonnage of the last eleven months on the Reading railroad, with all the disadvantages of a want of sufficient machinery early in the season, already exceeds that of any double or single track railroad in the country, and it is believed, that of any single track railroad in the world.

It amounts, as per statement B, to 317,277 tons.

Although material reductions will be made, as before stated, in many items of the expenses of the road, for the coming year, the undersigned may yet solicit a comparison of the expenses of the department entrusted to his charge, with those of other railroads, considered the best and most economically managed in the eastern States.

It will be found that the average expense of ten of the most important of these railroads is six per cent. per mile over that of the Reading railroad, while that of only *three* is less—each with a tonnage supposed not more than one-tenth of that of this road.

The average weight of loaded coal trains down the road during the past eleven months, including the cars, has been 299 tons, equal to $49\frac{8}{10}$ cars loaded with $3\frac{1}{4}$ tons of coal each, or a nett weight of 161·8 tons (2240 lbs.) of coal to each train. The average weight of empty coal trains up the road, for the same period, has been 121 tons, equal to $50\frac{4}{10}$ empty coal cars of 2 tons 2 cwt. each.

The gross expenses of the transportation department of the road are exhibited in detail in statement C. It is proper to state, that some portion of these expenses were necessarily larger on the *commencement* of a business of such magnitude, without the required facilities for carrying it on—such as turn-outs, track room, machinery and workshops, and supply of water to water stations. A very considerable portion also of these expenses may be considered permanent, and are but slightly increased by a business double or treble that hitherto done on the road. Among the latter expenses may be enumerated the repairs of road-way, salaries of officers and agents, stationery and printing, hauling across Schuylkill bridge, wages of watchmen, coal for offices and stations, wages of depot hands, in part, materials for depots, water rents, etc.

The experience gained by those in charge of the several departments of the road, will prove most valuable to its business for the future in decreasing its expenses and adding to its facilities.

The expenses for the coming year will show a considerable saving in several important items, which may here be alluded to: All the brass castings and coppersmith work of the line are now done at the company's workshops at Reading, under the superintendance of the foreman, of a much better quality than were before purchased elsewhere, and with a saving of two-fifths of the expense.

Babbit's patent friction metal has been introduced very successfully into all the running gearing of the engines, as well as the car boxes, with a saving of friction, oil and wear and tear. Ray's patent spring is now used altogether on the road, with a saving of one-fourth in weight and expense.

A considerable proportion of the repairs of coal cars was on account of axles, mostly of inferior quality, breaking on the road. An arrangement has been made with an eminent manufacturer of these important articles, by which axles of a most superior quality are furnished at a trifling advance upon those which have proved defective, with which the latter are replaced when found necessary.

It is believed that great advantages will result to the road by using sheet iron coal cars, one of which is now building by the company. It will weigh but $2\frac{1}{4}$ tons, will carry 5 tons of coal, will last much longer, cost less for repairs, and diminish the cost for carrying coal about 20 per cent., by the greater proportion of useful to useless weight.

An economy is also anticipated in the use of steel axle journals and chilled cast iron boxes, in the coal cars, by diminishing friction and the quantity of grease required.

On reference to statements C and D, of the expenses of the road, it will be seen that the sum paid the State for tolls and motive power, over the $3\frac{1}{4}$ miles of their road, during the past eleven months, amounted to $12,384 57. To this must be added the expenses of hauling across the Schuylkill bridge, and extra conductors, watchmen, etc., making a total of $13,670 07 for the eleven months, or $14,912 80 per annum.

The cost of conveying a passenger from Pottsville to the junction with the State railroad, $89\frac{1}{2}$ miles, has been, during the past year, $38\frac{7}{10}$ cents, including pay of engineer conductor, fireman, fuel, tallow, water, oil, repairs of engine, tender and cars.

The amount paid to the State on each of these same passengers, for use of the $3\frac{1}{4}$ miles of their road and motive power *above*, is $13\frac{1}{2}$ cents, besides the cost of hauling across the Schuylkill bridge.

The cost of hauling coal over this road, from the junction of the Reading railroad to Philadelphia, not including repairs of cars, is $14\frac{1}{4}$ cts. per ton.

In conclusion, it may be confidently stated, that the future prospects and value of the noble improvement under your management is most encouraging.

It stretches from the most extensive anthracite coal region in the United States, to its second city in population and importance.

The supply of the material constituting its chief dependence for tonnage is inexhaustible, and is mined by a hardy, enterprising and rapidly increasing population, and can pass to the Philadelphia market by no shorter or more direct route than the Reading railroad.

In the carriage of its coal to tide water, it is assisted by the power of gravity overacting in the required direction of the descending trade, through a fall of 590 feet, and so spread over the 94 miles, that the power of the engine in taking back its empty train, is no more taxed than when hauling the previous train loaded over a level.

The length of the road allows neither more or less than one good day's work per trip of 94 miles to all hands employed on the train, and therefore secures a *maximum of economy* in the item of men's wages.

The article carried cannot be stolen, lost or destroyed; and even in cases of accident, it is taken and used by the company at cost price.

The valley of the Schuylkill, through which this railroad passes, is one of the richest in the State in fertility of soil, mineral and agricultural productions. Iron in every stage, from the ore to the bar, lime stone, grain, flour and all the produce of the farm and the forest, are within reach along its whole route, and, with the accompanying travel, contribute to its revenue.

Its ability to command and transport the whole of this trade will go on increasing, since every year presents new improvements in the management and machinery of railroads, tending to their economy and efficiency.

All which is respectfully submitted, by your obedient servant,

G. A. Nicolls,

Sup. trans. mot. power and machinery Phil. Read. and Potts. railroad.
Reading, Pa., Nov. 30, 1843.

Statement A.

Amount of running machinery on the Philadelphia, Reading and Pottsville railroad, November 30th, 1843.

23	8 wheeled engines, from 11 to 13 3-4 tons.	1592	4 wheeled coal cars.
7	6 " " " 10 1-2 to 12 1-2 "	12	8 wheeled passenger cars.
8	4 " " all 8 4-10 "	2	4 " " "
1	4 " for use of anthr. coal, wt. 10·43.	6	4 " baggage "
39	in all. Above weights in running order.	20	in all.

189	4 wheeled truck freight cars.
1	8 " " "
16	4 " covered, "
2	8 " " "
208	in all.

Engines and cars contracted for, not yet delivered—1 locomotive engine, of the heaviest class, for Falls grade, from Newcastle Manufacturing co; 24 open freight car truck bodies to be mounted as covered cars.

Statement B.

Of amount of business on the Philadelphia, Reading and Pottsville railroad, for the first eleven months of 1843.

Total amount of coal transported in tons of 2240 lbs.,	218,711
" mdze. " " 2000 "	17,534
" tonnage for use road, earth, rails, stone, sills, pipes etc. 2000 lbs.,	54,757
Total tonnage of road, in tons of 2000 lbs.,	317,277

Total number of passengers transported,	56,564
" " miles travelled by the same,	2,457,429
Equal to, in through passengers over whole length of road,	26,494
Gross receipts from passenger travel,	$71,895 21
" " freight on merchandize,	37,926 57
" " " coal,	278,840 20
" " transportation of United States mail,	5,500 00
" " all other sources,	156 51
	$394,318 49
Deduct debts outstanding, due company, Nov. 30th, 1843,	9,123 10
Nett receipts of road for 11 months,	$385,195 39

Statement C.

Gross expenses of the transportation department for the first eleven months of 1843.

RUNNING ACCOUNT.		
Wages of engineers, conductors, breakmen, etc.,	34,449 21	
Fuel, 15,554 5-8 cords wood,	36,182 44	
Oil, 5,796 1-2 gallons,	4,375 81	
Tallow and lard,	2,008 72	
Columbia railroad expenses, amount paid State,	12,384 57	
" " hauling across Schuylkill bridge,	1,010 00	
Hauling cars in Broad street,	884 84	
Loading and unloading wood and freight,	2,221 85	
Renewals of articles for coal trains, ropes, lamps, etc.,	1,108 64	
Cotton waste,	364 15	
Goods damaged, stolen or lost,	103 13	
Coal broken on road, and used by company,	698 28	
Sundry small items,	1,227 73	97,029 37
WORKSHOP ACCOUNT.—[See statement E and F.]		
Wages of mechanics, at repairs, engines, cars, etc.,	23,058 06	
Bar iron, steel and other materials for do.,	9,828 68	
Iron and brass castings, and copper work,	2,443 08	
Timber for repairs, engines and cars,	1,600 73	
Coal for stationary engine and smith's fires,	786 44	
Sundry small items,	566 51	38,283 49
DEPOT ACCOUNT.		
Wages of depot hands, pumping water ($4,460,) watchmen, etc. ($1,804 50,) cutting wood, tending freight, etc.,	18,650 38	
Bills of cutting wood,	1,333 51	
Coal for water stations and offices, 148 1-2 tons,	610 06	
Water rents,	255 00	
Taxes on property and real estate,	324 73	
Sundry small items, materials, etc.,	607 97	21,781 65
OFFICE AND SUPERINTENDANCE ACCOUNT.		
Printing, advertising, stationary, furniture, articles for offices, & rent,	2,114 94	
Fees of magistrates, law expenses, etc.,	154 92	
Salaries of all officers, agents, and clerks in department,	12,269 36	14,539 22
Gross expenses of department for 11 months,		$171,633 73

Statement D.

Nett or actual expenses of the first eleven months of the year 1843.

Transportation of 218,711 tons of coal, from Pottsville and Schuylkill Haven to Richmond, on the Delaware, and to junction with State road, at 46 cts.,	$100,607 06
Transportation of 26,424 passengers to junction State road at 38 7-10ths cts.,	10,226 00
Transportation of 17,534 tons merchandize, between Pottsville, Reading and other points, and State road, at 66 1-2 cents,	11,660 11
Transportation of sundry materials for use of road, including 40,484 tons of earth, 1274 tons rails and iron for track, 8,031 tons sills and stone, 56 tons pipe, and sundries, amounting to 54,787 tons, at 5 cents,	2,739 35
Superintendance and salaries of all officers, agents and clerks, and coal agents at depots,	13,790 61
Expenses on Columbia railroad and in Broad street,	14,471 91
Wages of watchmen at depots,	1,804 60
Sundry repairs to, and materials furnished depots,	1,198 42
Making patterns, tools and sundries at workshops,	1,500 51
Over,	$157,996 56

Brought up,		$157,395 96
Additions and alterations of locomotive engines, as sand boxes, waterpipes, etc.,		962 52
Alterations and additions to Reading workshops,		496 40
Making and fitting up machinery for do.,		559 93
Building and altering four wheeled into six wheeled tenders,		1,278 97
Office exp's, printing, stationary, advertising, furniture, coal, rents, materials, etc.,		2,619 08
All other expenses not enumerated, taxes, etc.,		634 84
Actual nett expenses,		$164,549 30
Add for materials on hand as follows:		
Wood,	$2,774 40	
Iron, cast and wrought, and steel,	1,120 00	
Iron and steel, made up,	987 33	
Wheels and axles,	234 26	
Engine and car fires,	370 53	
Copper work, made up,	353 33	
Brass, lead, etc.,	701 15	
Bituminous coal,	200 00	
Timber and lumber,	343 33	7,084 43
Gross expenses,		$171,633 73

Statement E.

Repairs of locomotives, for the first eleven months of 1843.

Cost of all materials used, iron, steel, brass, etc.,	$2,208 71
Wages of mechanics,	9,804 90
Superintendance, oil, tools, paints, etc.,	1,210 62
Equal to 4 2-10 cents for each ton of 2000 lbs.,	$13,224 23

DETAILS OF WORKING OF ABOVE ENGINES.

Total number of miles run by heavy coal and freight engines,	313,392
Total number of miles run by light 4 wheeled passenger engines,	79,800
Total number miles run,	393,192
do. do. tons hauled one mile,	50,797,126
Average gross weight of loaded coal trains down the road, exclusive of engine and tender, in tons,	299
Average gross weight of empty coal trains, up the road, as above,	121
Average gross weight of passenger trains, in tons,	26
Quantity of sperm oil used by coal engines and tenders, per trips of 90 miles with above trains, in quarts,	399
Quantity of sperm oil used by passenger train engines, per trips of 90 miles in qts.,	269
Total number trips of passenger trains,	667

Statement F.

Repairs, and working of coal, freight and passenger cars, during the first eleven months of 1843.

COAL AND FREIGHT CARS.

Cost of all materials, iron, steel, brass, etc.,	$2,617 12
" timber and lumber,	1,386 89
Wages of mechanics,	9,013 56
Superintendance, oil, tools, paint, etc.,	1,301 74
Total cost,	$14,319 30
Or 4 1-2 cents per ton of 2000 lbs.	
Number gallons oil used by freight and coal cars,	1,580
do. lbs. tallow do. do.	29,133

PASSENGER CARS.

Cost of all iron, timber and materials,	$243 28
Wages of mechanics,	559 16
Sundry charges, glass, paint, varnish, etc.,	100 30
Total cost,	$902 74
Equal to 3 cents per each through passenger.	
Number gallons oil used by passenger cars,	25
Number pounds tallow used by do.	1,066

For the American Railroad Journal and Mechanics' Magazine.

COST OF TRANSPORTATION ON CANALS. BY W. R. CASEY, CIVIL ENGINEER.

The great object of canals and railways is to reduce the cost of transportation to the lowest practicable limits which yield a reasonable income on

the capital invested in their construction. A correct understanding of the rates of toll requisite to insure this fair return is, therefore, of vital importance. It is not strange that great difference of opinion should prevail as to the cost of transportation on railways, for the only road in the country built for the accommodation of a large business in freight, has been but a few months in full operation. Still its friends and foes have ventured to prophecy its success and ruin with the utmost confidence.

It is however strange that an equal difference of opinion prevails as to the cost of transportation on canals. The president of the Schuylkill navigation company states,

"In the past season the whole charge for carrying coal upon the Schuylkill navigation, including freight and toll, has been less than one cent and a quarter per ton per mile, and it may be materially reduced hereafter."

From this we may conclude that he looks forward to a total charge of one cent per ton per mile, the toll being one-half cent per ton per mile. At this rate the Erie canal would be a complete failure, and the Delaware and Hudson canal requires eight mills per ton per mile, nett profit, to pay a reasonable dividend. The Schuylkill canal must, therefore, have advantages of which we in New York know nothing, having always considered the Erie canal as not only unsurpassed but unrivalled by any similar work in its favorable location, small cost, moderate lockage, immense business, and, more than all, its rigorous monopoly.

The Erie canal is 363 miles long, has 698 feet lockage, cost to this time at least $10,000,000; ordinary expenses about $1,000 per mile per annum, and with extraordinary repairs and renewals about $500,000 per annum.

In 1840, there moved on the canal 829,960 tons, the income was (less $58,458 87 for passengers) $1,478,141 62=$1·781 per ton. The average movement in 1839 was determined with precision, and was 154 miles. The freight that year was 848,007 tons. (Assembly doc. 1840, No. 306, p. 38.) Now $1·781÷154=$0·0115 per mile per ton of 2000 lbs.=·01288 per 2240 lbs. per mile=more than 150 per cent. advance on the charges of the Schuylkill canal.

$$\text{Again, } 829{,}960 \times \frac{154}{2} = \$639{,}069{\cdot}20$$

Less ordinary expenses,	363
Leaving for renewals and interest,	$276,069·20

or $2\frac{3}{4}$ per cent. on the low estimate of $10,000,000. This is however taking the ton at 2000 lbs., but the reader will probably consider the "reductio ad absurdum" carried far enough.

In the elaborate report above alluded to, in which every thing connected with the Erie canal is tinted "couleur de rose," it is said, (p. 39,)

"The actual cost of transporting a ton on the present canal, including every species of expense, except tolls to the State, is, on the average, nine mills per mile."

It is not stated whether this includes the profits of the forwarder, but it is less than the average charge of last year, which was at least $11\frac{1}{4}$ mills per

mile per 2240 lbs. for flour, the favorite cheap down freight on the Erie canal. But, neglecting this, we have cost of transportation,

$$\left.\begin{array}{ll} & \cdot 009 \\ \text{add toll,} & \cdot 0115 \end{array}\right\} = \left\{\begin{array}{l} \cdot 0205 \text{ per 2000 lbs per mile, total average} \\ \text{charge at this time.} \end{array}\right.$$

The 25 or 30 millions to be expended in the enlargement will, as its friends "fondly hope," reduce the cost of transportation one-half;

$$\left.\begin{array}{ll} \text{that is to} & \cdot 0045 \\ \text{add toll,} & \cdot 0115 \end{array}\right\} = \left\{ \cdot 0160 \text{ per ton of 2000 lbs. per mile,} \right.$$

or ·01792 per ton of 2240 lbs. This is the lowest estimate of the most sanguine friends of canals in this State, it anticipates an increase of business boundless as the west, and a firm continuance of the State monopoly.

The Delaware and Hudson canal is 108 miles long, and brought down in 1842, 205,253 tons of coal, at a cost of $274,020 46, exclusive of toll. This is at the rate of $1·335 per ton of (I suppose) 2240 lbs., or ·01234 per ton per mile. The statement of the company is annexed, and it will be seen that they receive very nearly 2¾ cents per ton per mile for the entire distance of 108 miles of canal, and 16 miles of railway. The "nett profit of the year is $196,051 51, being over ten per cent. on the capital stock of the company." The cost of the works is not given, but as they owe the State $800,000, on which they pay a low rate of interest, it must be about $2,-000,000, so that the Delaware and Hudson canal pays 7½ per cent. on its cost, at the above rates and with the above business

Statement of the expenses of the Delaware and Hudson Canal Co. for 1842.

To coal on hand, 1st March,	$104,870 00	By sales of coal,	$781,169 87
" Mining coal,	107,683 99	" Canal and railroad tolls,	33,894 93
" Railroad transportation and repairs,	115,755 85	" Interest received,	23,845 74
" Freight of coal to Rondout,	274,020 46	" Coal on hand,	124,691 50
" Canal repairs and superintendance,	77,078 91		
" Labor and expenses at Rondout,	21,793 69		
" Interest on State stock,	38,500 00		
" " Company loan,	4,620 00		
" Salaries, current expenses, rents, etc.,	23,227 63		
Balance,	196,051 51		
	$963,602 04		$963,602 04
March 1, 1843.		By balance,	$196,051 51

Flour has been for many years carried from Albany to New York for 12½ cents per barrel, or 8¾ mills per ton per mile. It is now carried for 10 cents, or 7 mills per ton per mile. Were the distance reduced from 150 to 108 miles, the cost could scarcely be less than 7½ mills, or 50 per cent. more than the forwarders on the Schuylkill canal are to receive according to Mr. S. W. Roberts, the president of the Schuylkill navigation company, and, I presume, the well known engineer of that name. On the Hudson they have also a vast quantity of up freight paying one to two cents per ton per mile; besides crowds of emigrants.

I confess my inability to comprehend that the Schuylkill canal should in any way rival the Hudson—as for exceeding it, a highly respectable miracle will be required to enable me even to entertain the proposition. It will be fortunate indeed if the present rivalry between *the* canal and *the* railway does not terminate in a case more appropriately falling within the jurisdic-

tion of the patron saint of Pennsylvania—the Rev. Sidney Smith—than within the province of the engineer.

A variety of minor considerations may be advanced which would make the case of the Schuylkill canal appear a little better; the same may be said, and to a greater extent, of the Erie canal. To these I may allude in another number of the Journal.

New York March, 1844.

REPORT OF THE SCHUYLKILL NAVIGATION COMPANY TO THE STOCKHOLDERS.

(Continued from page 51.)

Originally a depth of three feet was aimed at, in constructing the canals and pools; but has since been increased to four feet, and, in many places, to much more; but the shallowest parts must of course limit the capacity of the navigation. During the past season, the levels have been kept full, and one boat, No. 169, called the "President," came down, drawing 49 inches of water, and carrying 71 tons, 9 cwt. of coal.

In these days of keen competition in the coal trade, it is a matter of great interest to reduce the freights as much as possible, and this may most easily be effected by increasing the loads. An enlargement of the canals and of the locks would be attended with great expense, and would require boats of different dimensions from those now in use. The question of accomplishing the same end by a more simple and less expensive process, thus acquires additional importance.

It has been found by careful experiments made this season upon boats in use, that a good boat, when drawing 46 inches water, will carry 66 tons; and that every additional *half inch* displaces one ton of water, or adds one ton to the boat's capacity of carrying. So that when the boat draws seven inches more, making 53 inches, or 4 feet 5 inches, it will carry 14 tons more, making 80 tons; and, in the same proportion, a draught of 5 feet 3 inches, will carry 100 tons, which has been verified by actual experiment with the boat "Wm. P. Cox," No. 472, which, having brought 64 tons of coal to Philadelphia, was loaded to 100 tons, with the above draught of water, and carried her cargo to New York.

Seventy cents per ton is found to be a fair price for freight from Pottsville to Philadelphia, with a boat carrying 60 tons and a steady trade. Suppose the shallow parts of the navigation to be deepened a few inches, and the boat thus enabled to carry 80 tons. This gives an addition of one-third to the tonnage, and reduces the freight per ton in nearly a corresponding proportion, for the boat requires no more force to manage it. Another advantage is a diminution of the number of lockages, and consequent economy of water for a given amount of freight. The same reasoning will apply to a greater increase of depth and tonnage, and it will no doubt ultimately be accomplished; but the mark of 80 tons seems to be attainable without any large expenditure, and with many of the boats now upon the line; and any increase in the column of water, in the shallow parts of the canal, will be an advantage to every boat, by diminishing the resistance to its motion.

With a view to obtain correct information in reference to the subject of deepening the navigation, the managers have directed the line to be examined and sounded throughout its length, which is now in progress.

In the past season, the whole charge for carrying coal upon the Schuylkill navigation, including freight and toll, has been less than one cent and a quarter per ton per mile, and it may be materially reduced hereafter.

Let us now compare this charge with the expense of railway transporta-

tion as ascertained from the experience of a series of years, in England, where wages, fuel and iron are cheap, and where there is intense competition between the different coal districts.

An eminent English engineer, by whom several important railways have been constructed, Charles B. Vignoles, professor of civil engineering in the London University, has recently given to the public the following results:

"The cost of carrying coals, at very moderate velocities, on the great colliery railways, is about one penny (equal to two cents) per ton, which may be divided into the following heads, viz:

EXPENSE OF TRANSPORT OF COAL.

	Decimals of a penny.
Locomotive power,	·38
Wagons,	·19
Conducting traffic,	·08
Maintenance of railway,	·21
General expenses, including local taxes,	·14
Per ton of coal per mile,	1·00 or 2 cts.

"The proportion of the oweight of the coal to the gross load carried being as 3 to 5. The expense of carrying goods on the Liverpool and Manchester railway, taken on the average of seven years' traffic, appears to be about two and a half pence (equal to five cents) per ton per mile."

This however includes half a penny for the expense of collecting and delivering the goods.

The general results of English experience are thus tabulated; and we may remark, that they agree very nearly with the calculations of the cost of transportation on a number of American railroads, as given by Mr. C. Ellet, Jr., civil engineer, in his interesting essays on that subject.

"EXPENSE OF RAILWAY TRANSPORT PER MILE.

Passengers, at high velocities,	1d. (or 2 cents)	each.
Coal, at very moderate speed,	1d. (or 2 cents)	per ton.
Merchandize, at 15 miles an hour,	2d. (or 4 cents)	per ton."

Thus the expense of carrying merchandize, at 15 miles per hour, is twice that of coal, at about 5 miles per hour; half of which difference is due to the increased velocity. So that to carry coal, at 15 miles per hour, would cost three half pence, or three cents, per ton per mile, without including anything for interest or profits. [See Mr. Vignoles' sixteenth lecture reprinted in the Journal of the Franklin Institute for December, 1843.] In another place, Mr. Vignoles has observed, that he thought the proper railway *charge* should be double the *cost* for working; which, for transportation, at 15 miles per hour, would make the charge six cents per ton per mile, or nearly five times the present charge for carrying coal upon the Schuylkill navigation.

The spendthrift and prodigal policy, sometimes pursued upon railroads, soon after their first construction, of carrying heavy freight at high velocities and at low prices, less by far than sufficient to keep up the business, soon defeats its own object, and comes to a speedy end, when the ability to accumulate indebtedness no longer exists. With the weight of the load, and the rate of the speed, the wear and tear increase in a constantly increasing ratio, until the road itself, and its costly machinery and carriages are found to be involved in a common destruction. Though this conclusion may not at first be strikingly apparent, it is just as certain as the effect of over exertion and high excitement upon the human constitution, and much more speedy in its result; for a railroad, unlike the human frame, has nothing recuperative in its nature.

Nearly one half of the Schuylkill navigation is constructed in the river, deepened and improved by art, and the gentle current being in the direction of the heavy descending grade greatly facilitates its transportation; so that the river may be considered as a moving road, the surface of which is con-

stantly renewed by the bounty of Providence, in sending the early and the latter rain.

It is usual for eminent success to induce attempts at competition, and a portion of the increasing trade of the valley of the Schuylkill may for a time be diverted from its natural channel, but your president and managers are fully convinced, that no land carriage can long compete with such a water communication in carrying freight; and, believing that a judicious and firm administration of your affairs must lead to ultimate results which will both gratify your hopes, and justify their expectations, they have deemed it due to you to embrace a wider range than usual in this annual report, so as to give in some degree the grounds of their unshaken confidence in the intrinsic value of your noble work, from which you may draw your own conclusions.

All which is respectfully submitted,

SOLOMON W. ROBERTS.

January 1, 1844. *President.*

For the American Railroad Journal and Mechanics' Magazine.

BALDWIN AND WHITNEY'S SIX DRIVER LOCOMOTIVE.

Among the numerous improvements which have of late years conspired to *elevate the railroad system* to the high degree of advancement by which it is at this time characterized, there is perhaps none more calculated to secure to its projectors the award of well merited praise for ingenuity—and to the public a most essential benefit in the provision of an efficient basis for the reduction of railway fares, than the six driver locomotive engine recently designed and constructed by those enterprizing machinists, Messrs. Baldwin and Whitney, of Philadelphia.

To the character for skill and perfection of workmanship, which these gentlemen have so deservedly maintained, by the construction of engines of an excellence of finish, a symmetry of proportion, and a judicious adjustment of parts, unsurpassed by those of any other manufacturers in the world, they have now added that of bold but successful innovators, in presenting us with a machine designed on principles, the application of which to railway purposes is entirely new; and which, we may confidently assert, secure to the system a moter at once more powerful, and less injurious to the road, than any other which has hitherto been introduced.

This engine may justly be regarded as revolutionizing the railway system, at least so far as relates to its application to the roads of our interior, or of other sections where the command of pecuniary resources is comparatively restricted, and where railways must necessarily either be constructed with less regard to strength than those of more wealthy sections, or not constructed at all.

The ability to avail ourselves of the total amount of adhesion due to the weight of the engine, and at the same time to introduce more than four driving wheels, in order to distribute the weight among a number of points of contact with the rails sufficient to avoid injury from either abrasion, or too great strain upon a single point, has long been considered as a desideratum of paramount importance.

For some years past, many eminent machinists have been engaged in en-

deavoring to devise means for reducing the problem to a form that should be practically available; but with the exception of the machine of Messrs. Baldwin and Whitney, their attempts must be regarded as in a great measure abortive. The efforts of these gentlemen have at last been rendered successful by means of a happy application of the principle of the ordinary parallel ruler, by which they secure the constant parallelism of all the axles, and at the same time allow the wheels to adjust themselves, to a considerable extent, to the various curvatures of the road.

The connecting rods are furnished with ball and socket joints, which admit of motion in every direction without strain.

Careful experiments made upon one of our northern railways, for the purpose of testing the comparative merits of these engines, and of others in common use, have shown conclusively that the former experience less resistance from friction upon curves than the latter, thus placing at rest one of the most formidable objections that had been advanced against the six driver engines.

A careful account was kept of these experiments, and I am pleased to learn that the results are in the hands of a member of the profession, under whose supervision they were conducted; one eminently qualified for the task, and who will probably arrange and prepare them for publication in the Railroad Journal.

When the merits of Messrs. Baldwin and Whitney's engine become more generally known, I have little doubt but that it will in a great measure supercede all others of prior construction, especially for the carriage of freight. The number of drivers is by no means limited to six, but may be increased to eight or more if required.

It would be difficult to convey a very correct idea of the details of construction which constitute the peculiarities of this engine, without the use of drawings, which I have it not in my power to furnish at this moment, but which I may prepare to accompany a more specific paper on the subject in a future number of the Journal. The more immediate object of this communication is to direct the attention of railway companies, especially those whose roads are not of the most permanent construction, to a machine eminently adapted to their purposes, inasmuch as it obviates that most formidable source of injury, and consequent expense, the too great weight borne upon each driver of the ordinary engines.

JOHN C. TRAUTWINE.

We have frequently heard the improved engine of Messrs. Baldwin and Whitney spoken of by experienced engineers in very favorable terms, and have made quite an effort to obtain an accurate description of it, as well as a detailed account of its performance on the western railroad last fall, but have been unsuccessful in both; yet, we hope soon to receive from the gentleman who has the minutes of these experiments, a full report of its work, in comparison with other engines worked at the same time; and we now

call on the writer of the above communication, who is familiar with the improvements, and fully competent to the task, to furnish us with a description accompanied by illustrations, of the engine; that the numerous railroad companies in this country and Europe may, through this Journal, be informed of its excellence; and the ingenious manufacturers—whose modesty appears to exceed if possible their skill as machinists—may receive a remuneration equal to their deserts; and the travelling community derive the advantage which is sure to result from reduced fares. We trust that we shall soon hear from the gentleman referred to, and also from Mr. Trautwine again.—(*Eds. Railroad Journal.*)

ENGINEERS' AND MECHANICS' POCKET BOOK.—BY CHARLES H. HASWELL, CHIEF ENGINEER, U. S. NAVY.

We cordially recommend this little work to the notice of the profession, as containing, within the same space, more information likely to be useful—and that information, too, more skillfully arranged—than any similar work with which we are acquainted. It is beautifully as well as conveniently got up, contains 264 pages of matter well condensed, with only half a dozen blank leaves at the end, in place of being little more than a memorandum book for the year, as is the case with some of the English works of this description.

The tables are numerous and elaborate, comprehending very extensive ones of weights and measures, foreign as well as domestic; of areas, squares and cubes, natural sines and tangents, specific gravity, strength of materials, flow of water through pipes, weights of bar and sheet iron per lineal and square foot, etc. We understand that many of the tables and formulas have been re-calculated, by Mr. Haswell, who has spared no pains to combine accuracy with condensation—the great aim in such works.

To the civil engineer, when away from his books, it will prove an invaluable companion; and here we will venture to suggest to Mr. Haswell, that a table of natural sines and tangents to minutes, would have added materially to the value of his manual to the railway engineer, for we do not remember to have ever seen such tables in pocket form. Hassler's tables give the natural sines and cosines only, and they can hardly be called a "pocket book." A table to fifteen minutes will, however, be often useful, and perhaps it did not fall within the scope of his project, to devote a dozen pages more to this purpose. We repeat that nowhere have we seen so near an approximation to what an "Engineers' and Mechanics' Pocket Book" should be, as this little work of Mr. Haswell's.

RAILROAD REPORTS.

We are indebted—*not to the managers*, but—to a friend, for the eighth annual report, for 1843, of the directors of the Western railroad company. It came to hand too late for use in this number—but we refer to it for the purpose of saying to the managers of the various railroad companies, that we believe they would promote their own, quite as much as our interest, by

sending always to the Railroad Journal one of the first copies of their reports when published. Have the other Massachusetts companies made their annual reports yet? If yea—where are they?

We find in "The Civil Engineer and Architect's Journal," for January 13th last, the following statements, in relation to the use of wrought and cast iron for bridges. The wrought iron bridges are after the plan of "the wooden lattice bridges of America;" the origin of which style, the editor claims for "the late Mr. Smart of Westminister wharf, Lambeth." Possibly this may be the fact—but if so, the Americans have probably made some important improvement upon the original. Will those interested in the subject in this country give up their claim—or will they furnish us their statement for publication? We should like to publish an accurrate account of their origin in this country, but must rely upon those who posses the facts to furnish them.

The following papers were read before the Institution of Civil Engineers—January 9th, 1844.

By Capt. W. S. Moorsom, Assoc. Inst. C. E., descriptive of a cast iron bridge over the Avon, near Tewkesbury, on the line of the Birmingham and Gloucester railway. The principal novelty of this work, which was proposed, and its execution superintended by Mr. Ward, of Falmouth, is the mode of constructing the two piers, which were externally of cast iron in the form of caissons, each weighing about 28 tons; the plates composing each caisson were put together on a platform erected upon piles over the site of the pier, the bottom of the river being levelled by a scoop dredger, the caisson was lowered, and some clay being thrown around the exterior, a joint was formed so nearly water tight, that two small pumps drained it in six hours. The foundation being thus excavated to the requisite depth, the caisson, which sank as the excavation proceeded, was filled with concrete and masonry; cap plates were then fixed for supporting eight pillars with an entablature, to which was attached one end of the segmental arches 57 feet span, with a versed sine of 5 feet 2 inches. There were three of these arches, each formed of six ribs of cast iron, and two such piers as have been described, the land abutments being of stone work joining the embankment of the railway. It was stated that this mode of construction was found to be more economical in that peculiar situation than the usual method of fixing timber coffer-dams, and building the piers within them; the total cost of the bridge being only £10,192, and the navigation of the river was not interrupted during the progress of the work. The paper was illustrated by eighteen remarkably well executed drawings by Mr. Butterton.

A paper by Mr. G. W. Hemans, Grad. Inst. C. E., descriptive of a wrought iron lattice bridge erected across the line of the Dublin and Drogheda railway was then read. This bridge, which in construction is similar to the wooden lattice bridges of America,* only substituting wrought iron for timber, is situated about three miles from Dublin over an excavation of 36 feet in depth; its span is 84 feet in the clear, and the two lattice beams are set parallel to each other, resting at either end on plain stone abutments built in the slope. These beams are 10 feet in depth, and are formed by a series of flat iron bars 2 1-2 inches wide by 3-8 inches thick crossing one another at an angle of 45 degrees; at 5 feet 6 inches above the bottom edge, transverse bearers of angle iron are fixed similar to those now used for supporting the decks of iron steam vessels, and upon those the planking for the roadway is fastened. The account of the mode of construction, and of the raising and fixing the lattice beams, by Messrs. Perry, of Dublin, the contractors, was given in detail, and the author stated that, although it was expected that considerable deflection would occur, which was provided for by forming the beams with a curve of 12 inches in the centre they did not sink at all even when heavy weights passed over them. The total cost of the structure, including the masonry of the abutments was £510. It was stated that this bridge had been erected by Mr. Macneill, M. Inst. C. E., in order to test the soundness of this kind of structure before he applied it in a bridge of 240 feet span to carry the Dublin and Drogheda railway over a canal.

* The original inventor of the lattice bridge, was the late Mr. Smart, of Westminister bridge wharf, Lambeth, who many years since took out letters patent for the principle.—(Ed. C. E. & A. Journal.)

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For the American Railroad Journal and Mechanics' Magazine.

COST OF TRANSPORTATION ON RAILROADS.—BY CHARLES ELLET, JR., C. E.

(Continued from page 8.)

Wear of Iron Rails.—It was not my intention to deviate from the course which I had marked out as proper to be observed in the discussion and development of the important subject which I have attempted to exhibit, for the purpose of disposing of collateral points, or of refuting any objections that might be urged against my argument. But the matter presented in the December number of the Journal is of such deep interest to all concerned in the railroad cause, that I have been compelled to make frequent oral explanations and estimates, which could be more advantageously and more appropriately offered in their place in these articles. I propose, therefore, to recur briefly in the present paper, to the momentous question of the probable durability of the iron rails, and the pecuniary loss consequent on their destruction, for the purpose of presenting facts which it was my wish to postpone to a later period.

It is as impossible as it would be dishonest to attempt to promote the cause of internal improvement, or any division of that cause, by deceptive estimates or the expression of extravagant hopes. It is the duty of the engineer, as well as of the statesman, to look at things as they are, at this great system as it is. He must first recognize the weaker points before he can hope to fortify them. If companies or their officers, fail to estimate their expenses truly, they will inevitably fail also in their great objects; and instead of bringing blessings and prosperity into the country, public improvements will continue to be, as they have hitherto frequently been, the bearers of private ruin and public dishonor.

The prevailing fault of nearly all writers on railroad policy is that of yielding up their judgment to the dictation of their wishes, and exhibiting the facts as all desire them to be, and not as we find them. Hence the proverbial errors of companies and their agents, in undervaluing the first cost of their work; in over estimating its business, and underrating the cost of its maintenance. Their opinions are but the picture of their hopes, and rarely deductions from an extensive and systematic investigation, and a wide experience.

But we are now in pursuit of truth and shall endeavor to avoid this error.

The railroad system is new. It is not yet twenty-five years since the locomotive engine has been used with any decided success, and it is not fifteen years since its first employment on lines of general and extensive intercourse.

We have, nevertheless, much experience of the wear of iron rails; for a heavy trade—a trade vastly inferior to that of some of the canals of this country—is sufficient to produce great and obvious effects in a very brief space of time.

We cannot seek this experience, however, on the great railways recently finished in England. These carry but little freight. Their business is nearly confined to the conveyance of passengers; and though they really transport many tons of parcels and costly merchandize, and make a considerable show of business, the actual tonnage, compared with that of some of our important canals, is insignificant. Indeed, the public have not yet become accustomed to compare the actual weight of the trade which is transmitted along existing lines of railroads, and that which passes noiselessly through the old canals, and there are consequently few who have yet formed a just conception of their relative magnitudes.

The *London and Birmingham* railway has already cost about $30,000,000; and was graded with a view to the heaviest traffic; but the speed and accommodation which it offers are but slight compensation for the price of carriage at which they must be purchased. With all the labor bestowed upon this work; with all the outlay encountered to reduce the cost of transportation—the annual nett tonnage upon it is not greater *than five or six weeks' trade of the Schuylkill navigation.*

The *Great Western* road has cost some $32,000,000. The nett tonnage upon this line is still less than that upon the London and Birmingham. It does not reach 120,000 through tons per annum.

But the traffic upon these works, light as the tonnage is, has been sufficient, at the high velocity permitted, to produce great destruction.

The former commenced with two tracks of edge rail of fifty pounds per yard, and wore much of it out before the line was finished.

The latter commenced with a forty-four pound bar between London and Maidenhead, and had rendered it unfit for safe service nearly a year ago. The still heavier iron which they are now using is not, of course, yet entirely destroyed. But before this time next year—if my calculations do not fail—I shall produce evidence in this Journal, that a portion of these seventy-five pound bars, has also given way under less than 500,000 tons nett.

At present, however, I will confine myself to past experience, and endeavor to ascertain from *that* what sort of expectations we have a right to entertain for the future. The new English roads have added but little to our previous information on this head; but still we are not without a great deal of valuable experience; and it is the duty of those who seek for truth, and who seek to exhibit it to others, to profit by the best experience they can find.

In reference to the subject before us, we know,

1st. That some eight or ten of the railroads of this country, have worn out the common half-inch flat bar, with an average aggregate trade of 150,000 tons nett, drawn by locomotive engines.

2d. The Camden and Amboy road has, in places, worn out an edge rail weighing about 40 pounds per yard, with a trade considerably less than 400,000 tons nett.

3d. The edge rail on the Columbia road, weighing 33 pounds per yard, has not yet borne the passage of 350,000 tons on one track, and is nearly destroyed.

4th. On the Boston and Lowell road, a 36 pound rail was so much injured, or so much weaked, as to need renewing and replacing before it had sustained the passage of 600,000 tons nett.

5th. The Liverpool and Manchester road was opened in 1830. In 1835, the *first two tracks of edge rails*, weighing 35 pounds per yard, were destroyed and renewed; and the trade was less than 600,000 tons nett, on each track.

6th. In 1835, the Liverpool and Manchester company relaid the portion of their road next to Liverpool, with edge rails, weighing 50 pound per yard—or just five pounds per yard heavier than those of the Reading railroad. Before the close of 1840, these *new rails* (weighing, I say, 50 lbs. per yard,) were worn out, and taken up, and substituted by two other tracks of iron, weighing 64 pounds per yard. These 50 pounds per yard rails were destroyed by about 700,000 tons nett on each track. So that, in the brief space of nine years, this company destroyed four successive single tracks of edge rails with an average nett trade of about 300,000 tons per annum.

7th. The 64 pound rails next introduced on this road, were found to be *too light*, and a 75 pound pattern was substituted, which is now the adopted weight. These rails of 75 pounds have already begun to give way at unsound places—the injury "showing itself chiefly in lamination and occasional splitting at the edges."

8th. The Stockton and Darlington road, considered as a single track, has been *ironed* with edge rails from six to eight times.

Business commenced on this line about the year 1825. In the year 1834 the trade had reached 338,248 tons. In 1840 it had attained the extraordinary limit of 803,784 tons, and up to the year 1842, there had passed along the work a nett weight of nearly 6,500,000 tons. At that time six tracks had been destroyed, and taken up and replaced, besides the rails that each time were introduced, before an entire change of form was resolved on. How many tracks this patching may have amounted to, it is probably impossible now to ascertain. *The cars on this road are very light and the velocity but six miles per hour.*

It is probable that each track of this road has sustained nearly 1,000,000 tons; and with such cars, and at such a moderate speed, it is not impro-

bable that a 50 pound bar would sustain from 1,200,000 to 1,500,000 tons.

9th. The London and Birmingham 50 pound iron which was destroyed before the work was finished, sustained about 350,000 tons on each track. The velocity here was, however, exceedingly great, and the cars unusually heavy.

10th. The nett tonnage on the Great Western road, which destroyed the 44 pound iron, did not reach 300,000 tons of freight and passengers per track. The engines and cars are still heavier than those of the London and Birmingham road, and the average speed 25 miles per hour.

Now, these are facts; and this, whatever it is worth, is *experience*. The intelligent reader must judge from the facts, whether or not the cost of renewing iron ought to be regarded as one of the current expenses, or as a thing so extraordinary as to require to be excluded from the annual charges altogether, and added, as is now the universal custom, from year to year, to the cost of the road.

But the rapid destruction of iron under the action of a heavy trade, and the measure which, in the December number, I have assigned to its durability on the Reading road, where the velocity is from ten to fifteen miles per hour, is now but faintly denied; or, if denied at all, only by inexperienced parties, and in anonymous communications.*

A new view is accordingly taken of the subject, and the important question arises to determine the amount of loss to the company consequent on the destruction of the iron. I mean to offer no conjectures on this head either, but refer to known and admitted facts, as a guide to my conclusions.

I find in the last report of the Boston and Lowell railroad company—the only company in this country, which has renewed a considerable portion of a track of edge rails, in one year, and published the cost—the following charge:

"For labor and sundry materials, in taking up twenty miles of track laid with 36 pound rails, and replacing it by rails of 56 pounds per yard, exclusive of the cost of rail iron, $34,162 09." The year before the expenditure for this object was $14,608, so that for changing 25¾ miles of edge rail, the company incurred an expense of $48,770, or $1,900 per mile.

There are seventy-one tons of rails in a mile of the track of the Reading railroad, and the cost of taking up the old iron and putting down new, is, therefore, $1,900 for 71 tons = per ton, - - $26 75

A ton of new iron delivered in Philadelphia, will cost under the present tariff, - - - -	$60 00	
The old iron is supposed to be worth along the line, per ton, about - - - - -	25 00	
Difference between the value of new iron in Philadelphia, and old iron on the ground, per ton, - -		$35 00

* Since this was printed I have received the last number of the Railroad Journal, in which I find my views entirely disputed.

The cost of changing the iron track of the road will then be as follows:

Seventy-one tons of iron, taken up and put down, at \$26 75,		\$1,900
Difference between 71 tons of new iron bought at \$60,	\$4,260	
And 71 tons of old iron sold at \$25, - -	1,775	—2,486
Seventy-one tons of new iron transported to, and distributed along the line at \$5, - - -		355
Cost per mile of changing iron, - - - - -		\$4,740

This sum of \$4,740 will be the amount due to the trade which will destroy the iron, or render it unfit for safe usage. I know of no iron which has yet withstood the action of a million tons; and I know of no iron of 50 pounds or less, that is likely, at the usual speed in this country, to resist that weight. If we consider the rails of the Reading road to be capable of that effort, then we shall have 4¾ mills per ton per mile for the value of the iron destroyed by each ton of coal descending the line: or 44½ cents per ton for the whole distance of 94 miles. By adopting the rates of speed of the Stockton and Darlington road, it is probable that the cost of the iron could be brought down to 60 cents per ton, or near that limit; but if the company adopt the heavy cars, (7½ tons when loaded) and powerful engines, and heavy trains now contemplated, and continue the high velocity now permitted, the destruction of iron will probably be scarcely compensated for by seventy-five cents per ton.

This is a calculation from such data as we are able to obtain. But was there ever a calculation of such work, which was not exceeded by the practical result? One of the data assumes that there will be as many tons of iron to sell, as were originally bought. But the weight will not hold out. It is useless to inquire why; yet we cannot spread 70,000 bars of iron along a road 100 miles in length, and beat them and roll them for one or two years and then collect them all again. This is a practical difficulty which must always be encountered under such circumstances. The calculation assumes that it will not be collected; and, besides, that the 140,000 bolts, and the 70,000 chairs to be distributed and replaced, can likewise be found again.

Many visionary estimates have been made on this head, by parties of little experience in the handling of heavy materials, and in the performance of mechanical work; but the following practical facts are a great deal more forcible, and will be found to furnish data which can be applied with much more certainty than any speculative estimate whatever.

The *South Carolina* railroad was opened in the year 1833; the trade averages about 25,000 tons. In the semi-annual report for December 31st, 1838, five years after the completion of the work, we find the following:— "deduct the following expenditures, as being rather for permanent improvement than current expenses, viz:

Machiney, - - - - -	\$26,888 12
Spikes, - - - - - -	4,582 34
New rail iron, - - - - -	3,940 00 etc.

This hint to the experienced reader, is symptomatic of the contents of the next report, (June 30th, 1839,) from which I extract the following:

" Amount paid for rail iron in Charleston,	$371,679 12	
Less old iron *sold and unsold*, . . .	92,902 27—	$278,776 85
Cost of transportation of the same on the road, and laying down, including spikes, ...		74,400 00
Nett cost of new iron, . . .		$353,176 85"

Here we perceive that the entire sales of the old iron (when it was all disposed of, it yielded precisely $92,325 71,) exceeded the cost of putting the new rail in the track, but by some $18,000, while the nett cost of the new iron, after deducting the proceeds of sales, was $353,176. Such is in fact what is to be expected. *The old iron will barely pay for putting down the new, and the loss to the company will be about equal to the cost of the new iron delivered at the sea port.*

A writer in the Railroad Journal proposes a scheme for the Reading railroad to *make money*, by procuring rails free of duty, and selling the old material, after it has been worn out, with the advantages of the duty.

The operation was conducted under precisely those circumstances on the South Carolina road; but the above balance will show that the speculation did not turn out so well in that case. Indeed I have known many instances in which the iron has been renewed, but I have never heard of a company, here or abroad, that found the speculation a profitable one.

In the accounts of the South Carolina road, the new iron is charged to "permanent improvements," (the old iron lasted *five* years) and the company recommenced with augmented capital.

I have but one word to add in reference to the durability of iron rails, subjected to the action of a trade like that of the Schuylkill. I have already stated that if the Reading railroad company expect to obtain the whole trade of the canal, they must prepare for the entire renewal of a single track every year; and I now add, *if the company carry* 500,000 *tons of coal during the present year*, as they now propose to do, the new iron cannot be put down, before that now on the track will be so nearly destroyed as to be unsafe.

It is understood that this company has recently obtained an additional loan of $1,000,000. With this it is proposed to stock and equip the line, and procure the additional track, and prepare for the conveyance of the whole trade of the Schuylkill.

I therefore advance this additional proposition. After this money is expended, and the company shall have put themselves, by its aid, in the position which they seek to occupy, they will neither, in the first place, be able to carry more than *half the tonnage* of the Schuylkill, and, in the second place, if they succeed in obtaining half the tonnage, they will not be able to engage vigorously in the business of 1845, without a *new loan* of a million of dollars; and, finally, if they continue to operate through the present and the next year, they cannot engage in the business of 1846, without another loan

of at least one million. In short, waiving all regard to interest on their capital, it is *impossible for them to carry the Schuylkill coal trade, without borrowing one million of dollars per annum*. And when they cease borrowing they must cease carrying. I now dismiss the consideration of a road, which, in my opinion, was most unwisely commenced—which has been prosecuted in folly, and which can only terminate in disaster. On this result I desire to rest my claim to the public confidence.

Additional application of the formula.—In the November number of the Journal, I offered a formula for the computation of the annual expenses of lines of railway, and exhibited its application and agreement with the actual results on seventeen of the most important roads in the country.

The greatest deviation of that formula from the actual result was 12 per cent., which occurred in the case of the Baltimore and Ohio railroad for the year 1841.

In speaking of the deviations, I added these words: "It will probably be seen, on some future occasion, that those roads which now exhibit expenses above the formula, will fall below it for other years; a remark which is applicable to the *Boston and Lowell, Baltimore and Ohio and South Carolina roads.*" Since the publication of that article, I have received through the politeness of Mr. Latrobe, the able engineer of the Baltimore and Ohio railroad, the report of the operations on that work, for the year 1843, together with some valuable manuscript details, of which I hope to make useful application in the further prosecution of my present study. I am also indebted to Charles S. Storrow, Esq., the valuable superintendant of the Boston and Lowell road, for similar statistics in relation to the excellent, and, I believe, prosperous work under his charge, in anticipation of the publication of the report. I have also received from Mr. Storrow similar information relating to his line, for the year 1841, which I had not before obtained, and from the report of the Baltimore and Ohio railroad company, I find the facts necessary for the application of the formula also to the Baltimore and Washington road for the year 1843.

These results have all been procured since the publication of the formula; and I therefore proceed to test it by making the application to those lines.

It will be recollected that I offered, in the first place, a formula for the determination of the expenses for a *new line*, viz:

$$\frac{24\,N}{100}+\frac{9\,T}{1000}+\frac{7\,P}{1000}+300\,h.$$

And in the second place, a rule for the computation of the expenses of maintaining an old road, or road which had been opened more than four years, viz:

$$\frac{27{\cdot}5N}{100}+\frac{14\,T}{1000}+\frac{7\,P}{1000}+500\,h.$$

In both expressions, N stands for the number of miles run by the locomotive engines; T for the *tons nett* conveyed one mile; P for the number of passengers conveyed one mile, and h for the length of the road in miles.

In applying the formula to the Baltimore and Ohio road, it is to be borne in mind, that of the 178 miles in use for the year 1843, but 82 miles were opened previous to 1842, and that the whole of the remaining 96 miles is *new road.*

The result of the application to these several lines is exhibited in the three following tables:

TABLE.

Name of Road.	Year.	Length in miles.	Grades.	Miles run by trains.	Through tonnage.	Through travel.	Actual expenses.	Calculated expenses.	Error per cent.
Boston and Lowell,	1841	26	10	125,296	90,113	170,057	$119,469	$111,207	
Boston and Lowell,	1842	26	10	143,607	93,927	179,819	131,012	119,409	
Boston and Lowell,	1843	26	10	134,982	114,711	176,537	109,367	124,004	
Aggregate for these three years.				403,285	298,751	526,413	359,848	354,620	1 1-4

It will be recollected that I anticipated, in the November number, that subsequent results would be more favorable to the Boston and Lowell road, than that of 1842. We here find it so. In 1842, the formula fell $11,603, or 9 per cent. *below* the actual expenses. In 1843 the calculated expenses rise $14,637 *above* the actual expenses. But my remark in the December number should be recollected in these comparisons:—"The formula exhibits what it was intended to show—the average for a number of years." And hence, we have another test. The aggregate expenses on the Boston and Lowell road for three years are, as we observe by the table, $350,848. The calculated expenses, $354,620. This is surely close enough.

Again, we will take the Baltimore and Ohio road, for the year 1843, for the purpose of an additional application.

TABLE.

Name of Road.	Year.	Length in miles.	Grades.	Miles run by trains.	Through tonnage.	Through travel.	Actual expenses.	Calculated expenses.	Error per cent.
Baltimore and Ohio,	1841	82	82 1-2	299,617	44,477	34,380	$220,135	$192,925	
Baltimore and Ohio,	1843	178	82 1-2	509,765	39,519	33,670	287,153	322,075	
Aggregate expenses for two years,							507,288	515,000	1 1-2

I have taken no notice of operations on this work for the year 1842, because during that year the line was opened, in parts, from Harper's Ferry to Cumberland.

The application for the year 1841, gave a result of $27,210 *below* the actual expenses. I stated at the time that the subsequent expenses would be likely to fall *below* the calculated expenses. We accordingly find the result for the next year comes $34,000 below the formula. Here, then, is another and most conclusive confirmation of the correctness of the formula, and of the principles on which it is founded. If we take the *sum* of the expenses for the two years, we find the calculation $515,000, and the fact $507,288.

But we have yet a third case: the Baltimore and Ohio railroad report for 1843, exhibits, as has been stated, the results on the Baltimore and Wash-

ington road, likewise for that year. These, together with those of 1841 and 1842, are presented in the following

TABLE.

Name of Road.	Year.	Length in miles.	Grade in feet.	Miles run.	Through tonnage.	Through travel.	Actual expenses.	Calculated expenses.	Error per cent.
Baltimore & Washington,	1841–2	30 1-2		91,498	27,369	114,260	$73,684	76,166	
Baltimore & Washington,	1843	30 1-2		96,716	26,470	86,880	68,866	71,676	4

Here is an agreement within four per cent.

When I presented this formula in the November number of the Journal, and exhibited its application to seventeen lines of railway, I stated that these seventeen lines *were all the roads for which I had been able to collect the statistical information necessary for the application.* I had written to many companies, and had generally been supplied with the facts required, and which were not given in their reports. In some instances, however, they were unable to furnish the information which I needed; in two instances I received no reply to my letter; and in one—and I am happy to say one instance *only*—the officer declined making the affairs of the company public.

Since then the three companies above named have published their reports; and *they are the only reports for the year* 1843, which I have yet received. These reports add confirmation to the previous proof. Still I advance the formula as an approximation only, which I hope, with the aid of my professional friends, and future facts, so to modify and improve, as to render its application general and certain. It is the expression of the true LAW; but the *constants* are to be built up by multiplied facts, until there can no longer be room to doubt its indications.

I have endeavored, so far, to conform to the method which modern science points out as proper to be pursued in practical inquiries. Much injury has been inflicted on the great cause of internal improvement, and especially of railroad improvement, by the erroneous opinions of enthusiastic, but unwise advocates. But a new order of things has grown up, and a new system of inquiry is rapidly gaining ground. The seed of true principles has been sown, and the roots have struck deep into the soil of this country. Under the control of these principles, and the direction of cool and honest advocates, the railroad cause will take fresh growth, and flourish with a vigor and healthfulness which it has not yet exhibited. Some visionary and extravagant projects, which are now bearing heavy upon it, will sink under the pressure of their own weight, and serve, even in their ruins, as salutary guides for the future.

During the transition, TRUTH will be for a time obscured, and possibly borne down; but it cannot be overcome. It is sustained by a power which is invincible. Truth makes no compromise of principle—yields nothing for the sake of present popularity—contributes nothing to the cause of public deception—and moves fearlessly, surely, and, in the end, all-powerfully, to its mark.

[Note.—In the January number of the Journal, I offered an estimate of the probable expenses on the Reading railroad for the year 1843, in anticipation of the publication of any facts on that subject: assuming the travel at 40,000 passengers, and the trade at 250,000 tons. This estimate was $265,000. I regret to find, on perusing the last report, that the company have not thought it expedient to publish their expenses for the *whole year*; but have preferred to exclude the last month, along with the heavy bills which the close of the year usually brings with it. The expenses published, for eleven months, amount to $221,060 89. I should have been exceedingly gratified to know the amount of expenses for the whole year.

The indebtedness of the company since the date of the previous report of January 1, 1843, has been increased,	$1,252,659
The receipts for the first eleven months of the year amount to,	385,195
Aggregate expenditure for eleven months,	$1,637,854

A statement of the *items* which have consumed this enormous sum would certainly be read with interest and instruction; and it is greatly to be regretted that at this particular period, when the public are exceedingly anxious for truth and information, the directors have deemed it imprudent to publish it.]

Note.—The writer has expressed his opinions on an important subject without reserve, or concealment; should his *facts* be publicly disputed, or conflicting facts be presented, by any of his professional brethren, he trusts that they will have the consideration to do it over their own signatures, that he may have the guarantee of a name for the facts which *they* contribute. He will be found as frank in correcting his errors, if he has committed any, as he is sincere in the expression of his opinions.

(To be continued.)

For the American Railroad Journal and Mechanics' Magazine.

Gentlemen: On the receipt of the December number of your Journal, I immediately transmitted through the postmaster of this place, the sum of two dollars, for my subscription for 1844. My last payment was in November, 1842, of five dollars, for the year, from July 1, 1842, to June 30, 1843; but the change in the times of publication made this amount to cover the time up to December 31, 1843, as I understood. Am I right?

On the subject of the establishment of a society of civil engineers, I have a suggestion to make, which appears to me plausible, and much more facile in its execution than any other which I have seen proposed. The National Institute, for the promotion of science, established in the city of Washington, is now fully organized, and in most successful operation. It is organized into various departments: as the department of geology and mineralogy—of botany—of agriculture, etc. Many of the engineers of the United States are members of this Institute. Now, why should not the engineers generally, throughout the country, become members, and organize, (for this is a part of the plan of the Institute, if I understand aright,) in connection with the other departments, a "department of engineers." The advantages of this plan may be easily seen. The United States has comparatively a large

body of engineers in its employ—for independent of the two military corps, numbering, I believe, some 84 officers, there are numerous civil assistants and agents superintending the public works (I refer to all civil constructions —such as the improvement of harbors, rivers, building light houses, etc.— carried on by the government) in employ. The information which these gentlemen could furnish, as to prices of labor and materials, and plans of construction, under peculiar circumstances, of local works, etc., if properly embodied, would be of infinite service to the profession. All these gentlemen, being members of the institute, would give their hearty co-operation in forming the department of engineering. Washington city possesses many advantages over other places, for the meetings of the society. Although the States and private companies have in most instances carried on their works independent of the government, (that is, without its pecuniary aid,) yet the presence of some one officer of each work, has, at some time in each year, been required at the seat of government, to transact business in connection with their work, at the departments. This business could be transacted much more readily through the engineer of the work, more particularly when his connection with the institute will give him an acquaintance with the locality and means of obtaining every species of information that may be turned to advantage on the work on which he may be engaged. The existence, too, of the patent office there, where all new mechanical inventions are to be found, many of which are of great importance to the engineer, will prove a great inducement to them.

Another point. It is generally known that works on engineering, and the abstruse sciences connected with it, are high priced, they being generally the productions of foreign engineers and men of science, and published in Europe, and but few copies, comparatively, ever imported to this country. On account of their costliness, and the expense of transporting them from station to station, (for there are but few of our profession that can ever permanently locate themselves in one place, and have a "*home*," but must move from point to point, as the progress of the work on which they are engaged advances, or in search of new employment,) not many engineers can ever form for themselves a library, their low salaries and the heavy expense to which they are always subjected being another obstacle. In their visits to Washington this loss can be in a great measure removed, by the library of congress, and the libraries of the war department and the bureau, where copies of most of these works will be found, and the known courteousness of the officers, in whose charge they are placed, will render them at all times accessible to the profession. The library of the institute will soon be large enough to offer advantages to the man of science sufficiently ample to warrant the spending of some days within its walls, independent of the attraction of the museum, botanical gardens, etc.

Then as to the meetings of the department of engineering. Under the by-laws of the institute, each department holds its meetings independent of the general meetings of the institute. Now the objections to an independent

society of civil engineers are the most strongly developed on this one point—the almost utter impossibility of getting a sufficient number of the members together at the place of meeting to form a quorum. Under the organization I propose, one-fourth or one-third, (or indeed any number less than a majority,) of the department may constitute a quorum to organize a meeting, at which essays may be read, and conversations held on subjects connected with the profession; while the constitution and by-laws being already formed, and all changes in them being effected in general meetings of the institute, on the proposition, verbally, or in writing, of any member, there will not be the same absolute necessity of regular meetings at stipulated times as in the other case. The records of the department required to be kept of each meeting will show to those members who can only attend a few meeting, what has been previously done.

On the subject of the continuance of your Journal, one word. Although the results of these meetings of the department will be made known through the bulletins of the society annually published; yet it appears to me that the profession will require some other additional medium of communication, and that a great deal of statistical information, originating from these meetings, and from the free interchange of opinions among the members, may be promulgated to the world, which would not find its way into those bulletins. A regular monthly or semi-monthly Journal must be supported by the profession, and why not the one already established, and which has been so successfully carried on for twelve years past? Your plan of advertisements for travellers, too, is admirable. Every traveller has, time and again, felt the necessity for some such Journal, in which are concentrated notices of all lines of travel, whereby he may inform himself, before starting, of what route he can adopt to reach any given point to which business or pleasure may call him with the greatest convenience and despatch. An individual, for instance, starting from Boston or New York for New Orleans, if he adopts the sea route, knows what he has to encounter; but if he wishes to adopt the land route, he starts in entire ignorance, in most instances, of his means of locomotion, beyond some given point on his route, or its cost; nor has he any chance of determining which would be the speediest or most comfortable route for him. He may coast by railroads, steamboats, and stages along the Atlantic frontier, and the Gulf of Mexico; or diverging from this route in Maryland or Virginia, may strike the Ohio, where he will command a tolerably pleasant, and very often a comfortable and speedy journey by steamboat down the "father of rivers." Such will be the case, too, with the route through Pennsylvania. But the traveller knows not, perhaps, that an equally convenient, speedier and more comfortable route, during parts of the year, exists from Albany, through Buffalo, by the lakes, to Chicago, thence across northern Illinois by stages and steamers, (and in a year or two canal boats will vary the mode of travel through this region) to the Mississippi, where steamers await him every day for conveyance to the great commercial emporium of the south-west. Thus travellers, as well

as railroad, steamboat and stage companies, will derive immense benefit from your Journal. The proprietors of lines of travel would derive increased benefit in making their routes known beyond the mere region of country through which they pass, while the advertisements of manufacturers would make known to those interested, the cheapest and most expeditious means for repairs, etc.

In your November number of the Journal, I received a printed circular, on which I was taxed by the postmaster here with letter postage. The amount was, to be sure, very small, and on that score do not object to its payment; but the principle involved, leads me to mention that this system of circulars, (issued, too as this was, in an evasive way,) is very objectionable. To have refused to receive this circular from the office on my part, would have involved its authors in a suit by government, and a tax of five dollars, with the cost of prosecution. This I could not consent to do; yet I must protest against the system, as an imposition—and this is not the first nor the twentieth time that it has been *levied*—when it should have been paid by those who sent them. CHARLES N. HAGNER.

[The circular alluded to by our valuable correspondent was enclosed by the present editor, without a thought on his part as to the consequences, or a design, as he believes, on the part of the gentlemen who asked the favor, of dealing unjustly by others. The cause of complaint will not, however, again occur.—*D. K. M.*]

For the American Railroad Journal and Mechanics' Magazine.

Your correspondent "Y," in your February number, adverts to Mr. Ellet's *famous* plan of railways, for which the community was to be measured about as often as its individuals for their clothes, which at first were to be made as skimpy as possible and of no better material than *wood* from *head to foot*—neither safety nor comfort being necessary ingredients while *only a few travellers* were to be accommodated, but as these increased and lives only becoming of any importance *by their numbers*, stronger materials could be used, and the community, from time to time, remeasured and supplied with a new fit, as nearly conformable to its growth as the *irregular* character of this would permit, at one time standing still, and at another running up a foot in a night. This apparantly clever idea I recollect was not at the time, however, deemed feasible by you, nor has it since at all taken with the world at large, but on the contrary, it has come to be more evident that the *most substantial at the start* was the truest policy, and that *great expense* was necessary to true economy in railways. This discovery has had the good effect of preventing useless and wasteful outlay by laying them down where they were not wanted, as was often the case formerly. The railway here understood is that which is at all worthy of consideration or that accomplishes a speed of at least fifteen to twenty miles per hour.

In introducing this subject again, the evident aim of your correspondent is *to sneer* at the Reading railway, and spread as far as possible the same

sort of *slanders* against it as have lately filled the Philadelphia papers, but which happily were so gross as to lose their effect, and to fall still-born from the press—much to the mortification of their concoctors.

The impression which he would have prevail, is that the said railway in its necessarily large expenditures, gets no value therefor, and reach what they may, it can never be worth anything; or in his own words, "*its cost will be its only merit.*"

In the face of this, however, the canal he advocates as *even now* so much more efficient than this railway, has applied to the Pennsylvania legislature for leave to enlarge its capacity, as a means of better competing with this despised rival, and which it cannot do unless at a very heavy outlay, and with even then a doubtful result. Let the merit of the respective expenditures on these two works be impartially judged, and depend on it, the railway will be found to have spent nothing that has not secured to it a *more effective provision* for doing the business contended for.

The fact is, that some five or six years ago, a *notification*, then much laughed at by all the canals, was issued to such as were carriers of coal—the X pamphlet, bound in green, was the medium—that a *cheaper carrier* was then in course of construction, which, *when properly ready* would fully establish that fact. The Reading railway was here meant—which having now fairly entered the lists, the canals are found to wince already, and to vent their agonies, as before stated, in *vain abuse*, as if no warning had been given them.

When the *notification* alluded to, was issued in 1839, the cost by the canal given therein and afterwards *confirmed* by the board of trade of Pottsville, including freight at $1 28, and toll at 92 cts. per ton, with wastage, shipping, etc., was for coal, between Pottsville and Philadelphia per ton, $3 21

In that notification the *then* estimated cost by the railway in progress was 79 cts., exclusive of toll, for which may be added ½ ct. per ton per mile, say 47 cts., making the whole cost to compare with the above per ton, - - - - - 1 26

Difference as made in 1839 in favor of the railway, - . $1 95

At this day, however, in 1844, when all things have shrunk in value to near a minimum, and the competition of the railway has had some influence, we find as to the main items of freight and toll, these two rivals now standing as follows:

By canal, freight 70 cts., toll 36 cts., per ton from Pottsville, $1 06

To which is to be added, agreeable to the estimate of most of the operators, since they have had experience of the railway, sundry items to the disadvantage of the canal, amounting in all to - - - - 40—1 46

By railway, now while in process of receiving the trade, the charge for freight and toll is for the present between Pottsville and Richmond or Philadelphia, - - 1 10

$0 36

making a margin of 36 cents in favor of the railway, showing that if the whole toll were remitted on the canal, the railway could still retain the trade, and will hereafter no doubt avail itself of this favorable position to raise its rate to $1 25 at least.

The consumer has come off the best in this contest, the saving to him in round numbers being about $2 per ton, or on the whole present consumption of 1,200,000 tons, say $2,400,000, which may be employed in some other purpose of use or luxury. Next to the advantage obtained by this railway, of reducing the price of coal near *one-half*, will be that of securing a *uniformity of price* for it throughout the year, worth collaterally little less than the direct reduction of cost in the business it will attract. X.

RATES OF FARE AND RATES OF SPEED ON RAILROADS.

A great diversity of opinion exists in the public mind on these two subjects connected with railroads, in relation to which, as it seems to us, great accuracy is attainable. We have resolved, in consequence, on submitting to our readers our own views in relation to them, in the hope that they may, in some degree, tend to remove the confusion resulting rather, as it appears to us, from a disposition to generalize too far, than from a want of proper observation, or any difficulty in arriving at correct conclusions.

The proposition is often broadly laid down, that every reduction of rates on travel is attended with an increase, not only in the gross, but also the nett receipts of a railroad. Of course, pushed to an extreme, it is necessarily incorrect, or we should have to arrive at the conclusion, that *no fare at all* was the best case for a railroad. The proposition is undoubtedly true, that reductions of fare have *so far*, in our country, been advantageous to the companies making them. This, however, only proves that hitherto the fares on most lines of improvement have been above, rather than below the point of greatest advantage, not that they may not be very readily too low, as well as too high.

In looking into the subject, it strikes us that there is an entire analogy between the principles which should govern in the adoption of rates of fare on a railroad, and a revenue tariff on imports. The latter may be so high as to put a stop, in a great degree, to importation, or it may lead, in exposed situations, to smuggling, or both consequences may result. In the same way, a high rate of fare may be deeply injurious to a company, by diminishing the number of travellers, on their railroad, or in the case of unprotected lines, it may induce the adoption of inferior routes, or both results may ensue. The prosperity of the line of railroad communication between New York and Washington, for example, has, we have little doubt, been essentially retarded by injudiciously high rates. Between New York and Philadelphia, the monopoly has so far been complete, and the high rate of fare has operated mainly in reducing the number of travellers between these cities, to, we verily believe, less than one-half of what it would be, were the fares placed at two-thirds the present rates, with a somewhat higher rate of speed.

But between Philadelphia and Baltimore much more serious consequences must, it seems to us, result to the railroad line between those cities, should their present rates be kept up. Located as this road is, throughout its whole extent, parallel to the Delaware river and Chesapeake bay, nothing, we should think, could prevent the competition of lines of very fast steamboats in their waters, with barges on the canal connecting them, or connecting stage lines, but such reduced rates of fare and increased rates of speed as will set all competition at defiance, while on the other hand, very reduced rates of fare and higher speed would not only prevent all competition for the present travel on the route, but greatly increase it. We trust, for the sake of railroads, that the company will be wise in time, and act on the principle of the ounce of prevention being worth the pound of cure.

We cite these two case as the most striking that present themselves to us, of error on the side of high fares. Connecting, as the roads in question do, the largest and most populous towns in our country, and these in free States, where the temptation to travel is widely increased with every reduction in rates to the laboring class, and with every increase of speed to men of business, we know of no case in which low rates and high speed whould pay so well. There are, however, but few railroads out of New England on which the fares are not too high, and the speed for travellers is sufficient. Our eastern neighbors, so discerning in all matters of interest, have also found out the secret of success in railroads for travel. In the New England States, even between points of but little comparative importance, the speed is higher than in any other part of the United States, and the fares are generally low—from two to two and a-half cents per mile. As a consequence, we find on some of the railroads radiating from Boston, even those to small towns, (the Boston and Worcester for example) a greater travel than exists between New York and Philadelphia, and a much greater than between Philadelphia and Baltimore. We need not add, that notwithstanding their great cost, and this was in many cases enormous, the New England railroads have proved in almost all cases profitable. If the New Englanders were in some cases wasteful and injudicious in the construction of their roads, they have certainly given to us, in the matter of fares, and in other respects, the most valuable lessons in their management.

The circumstance of the railroad fares generally in our country being too high, is perhaps ascribable to the fact of many of them having been adjusted in the years 1835, 1836 and 1837, and their not being since reduced to accommodate them to the enhanced value of the currency on its present specie basis, or the diminished cost of all the necessities and luxuries of life. Three dollars per passenger between New York and Philadelphia, and the same price between Philadelphia and Baltimore, by the old Camden and Amboy and Newcastle and Frenchtown lines, were fair enough rates for the times when they were established, but two dollars now would be equally high, taking into consideration the price of every thing, as three dollars then. Instead of this, the fares on the present railroad routes, are four dollars on

each route, or twice as high, considering the increased value of money, as they were originally, and twice as high as it seems to us they should be, consistently with the interests of the proprietors of the railroads, not to speak of that of the public.

Our opinion in a few words is in substance this: that between towns of any size and in populous districts, rates not exceeding two to two and a half cents per mile, will be found most advantageous to the companies, even in protected lines, or those where there can be no competition, by the great increase they occasion in the amount of travel. The care, it will be seen, is greatly strengthened, where, as in the case of the Philadelphia and Baltimore railroad, the line is *unprotected*, and nothing but a very reduced rate can prevent competing lines. A grave error, however, would be committed, were these rules misapplied, and extended to the case of sparsely settled districts, in which from peculiar causes, the laboring classes cannot travel.

Such is the case in the southern States of the Union. If railroads can be sustained in these, it can only be, unless in a few cases, by *comparatively high* fares, because the laboring classes being slaves, would in the one hand afford no aliment for railroads, however reduced the rate; and their owners, whose engagements would be mainly on their farms and plantations, and whose journeys are generally limited to one or two trips during the year, for the sale of their staples, would be but little influenced in the number of their trips by the rate of fare being higher or lower. We use the term *comparatively* high, because we would not be understood as recommending *high* fares even in the south. We have little doubt that even in the slave States, the rates of fare are generally higher than the most judicious rates would be, but they certainly could not, with a due regard to the interest of the companies, be placed at as low rates as would be advisable in the northern and eastern States.

With regard to speed, we hold, that the rates of speed cannot, within any tolerably safe limits, be too high for travel, or within any convenient limits, too slow for freight. Many railroads in our country are at this moment unproductive from want of attention to this simple truth.

In the transportation of freight, there will be nearly, or very nearly, equal accommodation to those making use of the road, whether the rate of transportation be seven or fourteen miles per hour, and the same price would probably be commanded for the transportation of produce and merchandize, at one as at the other rate of speed. But there would be this great difference to the railroad company, that with an engine properly constructed for freights, it could not carry at a speed of *fourteen* miles per hour even half the load in produce or merchandize, that it could at a speed of *seven* miles, while the wear and tear of the engine, cars, and superstructure of the road, and risk of accidents would, for a given tonnage, be increased at least four fold, by doubling the speed. The cost of transportation, therefore, so far as these elements of it are concerned, would be increased in much more than a corresponding ratio with the rate of speed, and would on roads on which

fuel was cheap, be probably *three fold* the amount per ton, *for a double velocity.*

We cannot, in the limits of this article, demonstrate these positions with minuteness, but professional gentlemen will perceive at once their correctness. The deduction is, of course, irresistible, that on most of the railroads in our country, a rate of speed for freight is still practised, greatly beyond what is judicious, and, of course, if the transportation of freight is, in such cases, the source of any profit now, the companies may look to the same business as a source of great profit, as soon as their freight transportation shall be conducted with engines properly constructed, at slow velocities.

We say, *with engines properly constructed,* because the locomotives now in general use throughout the country, though susceptible of great improvement for the transportation of passengers, are, many of them, on the worst possible plan for freights. They have the advantage generally of only *half* their weight on driving wheels. They can therefore carry at slow velocities but half the load, which with the adhesion of their whole weight they would be capable of transporting. In addition this half is usually on *two instead of four* driving wheels. The engine is consequently twice as heavy on each driver, and much more than twice as injurious to the road, even at a slow rate of speed, as a locomotive would be of the same weight, (but double the power,) equally distributed on eight wheels, so connected as to give to the engine the advantage of its whole adhesion. The engines of Winans, on the Western (Massachusetts) railroad are on this principel, but unnecessarily weighty and cumbrous, in consequence of the adoption in them of the vertical plan of boiler; in our opinion particularly misplaced in a long engine on eight wheels, because in such an engine it occasions the necessity of great strength, and unavailable weight, (*except* for adhesion) in a cumbrous frame. With a horizontal boiler, (no frame worth speaking of being required,) nearly the whole weight of the engine is in its boiler and wheels. A horizontal engine of given weight can of course have a proportionally increased capacity of generating steam.

That such engines as we have described, or some modification of them, will ere long be introduced generally on our railroads for the transportation of freight, we cannot doubt, and when they are, and transportation shall be effected by them at slow velocities, the public will be not less astonished at the greatly diminished wear and tear of both road and machinery than at the improved efficiency of the locomotive. Such an engine as we describe, of from ten to twelve tons weight, and, of course, not exceeding one and a half tons on each wheel, would draw with ease, over the Philadelphia and Reading railroad, a load of five hundred tons gross, or about three hundred and fifty tons nett, and with obviously little more injury to the road than if the cars were drawn by horses, for the simple reason that the weight on each wheel would only be about the weight on ordinary car wheels.

But if such great advantages are to be anticipated from the introduction of low velocities, with suitable engines for the transportation of freight, we must

look to the development of an opposite principle for the attainment of the highest success in roads for the transportation of passengers. In these, the object must be a proper system of police and the improvement of the engine for high, instead of low velocities. Valuable as time is in our country, any reasonable increase of speed on passenger roads is abundantly justified by the great increase of travel induced by it. The great intercourse between towns very near each other, is in a great degree ascribable to the increased relations which grow out of their contiguity, and the more near, of course, that distant points are brought to each other by railroads or by increasing the speed on them, the more they approximate to the case of contiguous towns, and the more their intercourse is increased. If the trip between Philadelphia and New York was, for instance, made in four hours, which, it seems to us, it might easily be, instead of six, we cannot doubt that the trips of men of business would be twice as frequent as they now are between those cities, even at the present rates of fare; for they could then with ease and comfort go from one town to the other, transact their business, and return by an early hour of the evening. The same would be the result of a higher speed between Philadelphia and Baltimore, points between which the intercourse must be greatly checked by the present very slow rates of travel on the Philadelphia and Baltimore railroad. If, in addition, between these populous towns, there was not only a greater speed, but a reduction of fare, the effect on the travel would, of course, be greatly enhanced.

And this increased speed, so valuable in the case of passenger roads, could not for a long time be attended with the same proportionally increased cost, which would be requisite in freight trains, for this obvious reason, that on *most*, if not all, the railroads in our country, it will be many years before full loads of passengers can be had on them for engines of ordinary power, and in consequence the power of the engine expended in going at a high rate of speed, would be wasted at a low speed. Without reference, however, to this consideration, it will be at once perceived, that the great increase of travel, induced by higher rates of speed, while there is no corresponding advantage in the case of freights, is the principal cause of the difference in the speed proper for freight and passenger roads.

This being the case, we trust that the same attention which is now being paid to the construction of engines of slow velocity for freights, will be given to engines for the mail and passenger transportation. Such engines should have driving wheels of a diameter materially greater than that proper for freight trains. While three feet at farthest, with our notions as to slow transportation, should be, in our opinion, the maximum diameter of all the wheels of freight engines, as well as the guide wheels of passenger engines, the diameter of the driving wheels of the latter, on roads of great travel, should not be less than five feet. Of course, every precaution should be taken that such wheels are accurately set on their axles, and the flaunches of both the drivers and front wheels of the engine should be sufficiently deep (say 1¼ or 1½ inches) to avoid any risk of the locomotive being thrown from

the track by any obstacle but one resting on both rails, or so elevated on one rail as to overturn it. With these precautions and a proper police in relation to the road and machinery, we are inclined to think that a speed of 25 miles per hour at least may be attained on most of our roads, without any increase of risk at all correspondent to the greatly increased travel which would result from such speeds.

As to the item of risk, it should be born in mind that for passenger transportation, every precaution should be taken, and with such precaution, it does not appear to us, that at the rate of speed before mentioned, there is any material risk. If the axles and wheels of cars are of good materials and abundantly heavy, and every part of the engine properly proportioned, and leaning to the side of unnecessary strength. If no engine or car is allowed to leave the shops of the company without being closely inspected, and without the slightest repairs which may appear desirable being effected, there is really very little risk in railroad travelling from any cause, but blundering management in the arrangement of trains, by which a collision may take place, or from the designs of malicious persons, who may place obstacles on the track. The former is so serious a matter, at even the slowest rate of speed which travellers would put up with, that it must be guarded against by legislative provisions, and the strictest discipline at all hazards. From the latter, (obstruction in the track,) there is no danger to passengers, even should the locomotive be thrown off, if the baggage car, or cars, are put in front of the passenger cars, and the simple expedient of wooden couplings is adopted, to connect the engine and tender with the trains.

The above views will, we hope, satisfy many of our readers of the correctness of our proposition, of the propriety of high speed for travel and low speed for freight. We may perhaps present some further considerations on the subject in a future number, with comparisons between results on routes on which the policy advised by us, or an opposite one has been adopted.

For the American Railroad Journal and Mechanics' Magazine.

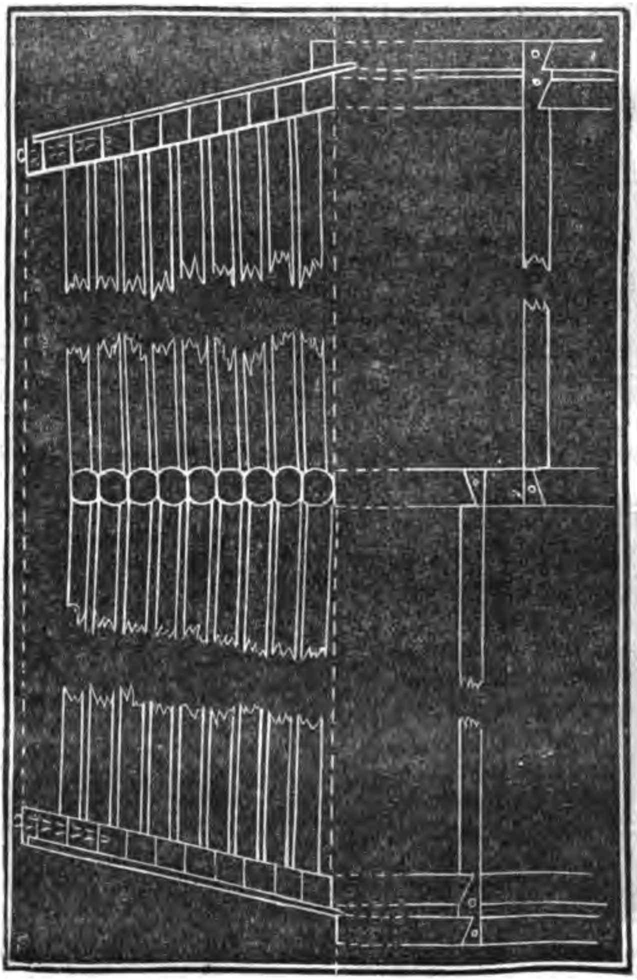
NOTES ON PRACTICAL ENGINEERING.—No. 6.

Wharves.

Although some may consider the remarks on the present state of bridge engineering not quite just, few will deny that the wharves, even of the great cities, are wretched affairs, whether we regard their present state, or their original projection, if, indeed, they ever had any. The extent of the wharves in this country is immense, and though all, or nearly all, of wood, there is still abundant room for the exercise of engineering skill in their construction, as well as in properly adapting them to the materials and business of their locality. These, as well as bridges, enter largely into the practice of the engineers of Europe; and the state of the wharves in this country is the wonder, but not the admiration of foreigners, and, perhaps, still more so of citizens, who have spent some time abroad. It will, of course, require a long time to produce a general change, but might not a commencement be made by strenuous exertions on the part of the profession?

The following account of the construction of a wharf for the northern terminus of the Champlain and St. Lawrence railway, and of the wharves at Monteal, may interest some of the readers of the Journal. The former runs out one-fourth of a mile into the river, is 32 feet wide, and ends in a T, with 200 feet front. A single track is laid on one side, the other side being required for carts and passengers. On the face of the T there is a wide platform for freight, and on the upper side of the wharf piles are driven at a distance of about 8 feet, and on these and on the edge of the wharf lumber is piled, so as to be ready for the cars without interfering with the traffic. On the approach of winter, the platform, turntables, office, etc. are removed, but the track is left, being secured to the timbers of the wharf. Ice soon forms in that climate, the river rises rapidly above the wharf which is under water from the beginning of December to the end of April, when the ice

Fig. 1.



dams below give way and the water falls in a few hours to its ordinary level. The piles to which the steamboat is moored, and which serve as fenders also, are drawn by the rising of the ice, they are then cut out, taken ashore, and driven again the following spring.

The transverse section, fig. 1, shows the mode of construction. The sides are formed of horizontal courses of white pine with a batter of 2 inches to the foot rise, the ties are of round tamarack below water and of white cedar above, they are 10 feet apart, 8 inches square at the outer end and let 4 inches into the superior and inferior courses. The face timbers are further secured by a piece of $\frac{3}{4}$ inches square iron, ragged, 3 feet long driven into a $\frac{3}{4}$ round hole, each 10 feet of each course. Ties break joints, not as in brick work, but by steps, as it were, so as to offer their entire surface to the slate with which the wharf is filled to the dotted line, fig. 1. The side or face timbers are capped with an oak plate, and on the T they are further steadied and secured by a block and strap firmly bolted to the ties and face timbers as seen in fig. 2. The face of the wharf is planked. The upper end of the planks are let 2 in. into the oak plate. as seen in figs. 1 and 2, and their feet are kept in place by the outer sill, which will be readily understood by the "plan" of the lowest course, fig. 1. The inner ends of the ties are dove-tailed into the middle longitudinal timbers, which are merely flatted, and of the cheapest kind of wood. The corners of the T are arranged as in fig. 3, which is a plan of the upper course with the oak plate removed. The face timbers lap at the corners, they are rounded off by a piece of oak, which with 3 or 4 of the plank, also of oak at this point, are firmly held in their places by iron straps bolted to the timbers, and also to a pile driven into each corner of the T. The foot of the oak corner timber is nearly triangular in section, and just fills the space between the face timbers and the outer sills, which are also lapped. After eight years exposure, these corners remain as at first. The wharf was commenced at the shore and

Fig. 2.

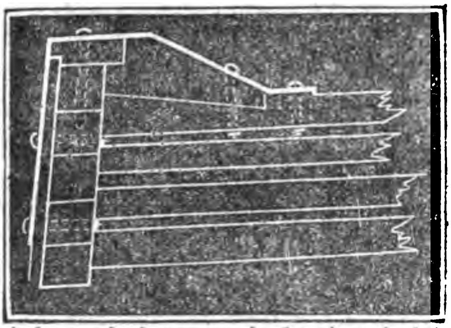
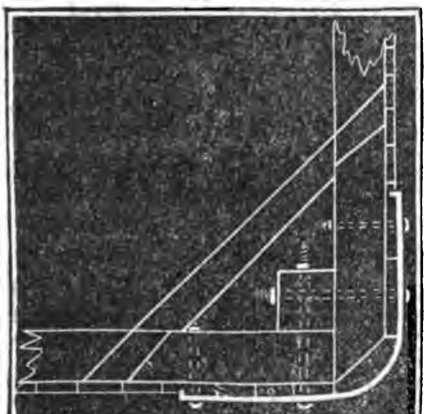


Fig. 3.



carried out 1200 feet in one continuous mass of timbers, the T was sunk at the end of the wharf, and held in its place by piles; the timbers above the level of the water are also continuous with the upper timbers of the wharf.

The river front of the city of Montreal is protected and adorned by a superb quay of cut lime stone, about 20 feet high, a mile in length and with numerous carriage ways leading down to the wharves. These are formed of piles of white pine about 14 inches square, driven at a slope of about 2 inches to the foot. They are grooved on the two edges so as to receive an oak tongue about 3×4, and are secured at the top by a heavy wale timber, at the back with blocks, ties and straps very nearly as in fig. 2, the face timbers of which occupy the place of the piles. The corners are rounded off very gently, which I think a mistake, as it sacrifices much room, and is in other respects inconvenient. A heavy iron strap is carried along the face at low water. The workmanship is unexceptionable, and the wharves might serve as models but for one defect, which would have been avoided had the plan been submitted to any competent engineer. The distance between the wale at the top and the bed of the river must be more than 20 feet, and the pressure from the filling in has caused the piles to bulge out, and in some cases has actually forced an opening between them. The wharves are under water several months, and when the river falls rapidly the outward pressure from the saturated mass must be immense. The effect of this thrust, though it could not escape the attention of the engineer, was naturally enough overlooked by the commissioners and the respectable builders employed by them. Except in very extreme cases there can be no difficulty in guarding against this thrust, and in many instances this mode of constructing wharves will be found very advantageous. A strong current is no very serious difficulty, and an uneven bottom, or one liable to wash—to a considerable extent—are no objections. The timber is in the best position for durability, and the piles may be bored down to the level of the water and filled with oil, tar or any other preservative. Had the present steam pile drivers been in use in June, 1835, I believe I should have adopted this mode of construction for the railway wharf. When in Montreal, in 1842, I perceived that they were building a new wharf of crib work, which was attended with some difficulty, on account of the slope of the river bank producing a tendency in the crib work to slide into the channel. They had even constructed a rude coffer dam to aid their operations, and after all it will be inferior to a piled wharf where the thrust is properly guarded against.

The wharves of the Reading railway are said to be admirably arranged, but I am unable to speak from observation of their merits in this respect, or of the mode of construction. The wharves described above are the best specimens of crib work and filling which I have met with, though like all other structures admitting of endless variety and improvement.

W. R. C.

New York, April, 1844.

We desire to make our acknowledgements to J. Williams, Esq., treasurer of the Boston and Worcester railroad company, for a copy of the "Annual Reports of the Railroad Corporations, in the State of Massachusetts," as made to the legislature, giving a statement of their operations for 1843. The reports of the different companies, like the works to which they refer, are got up in a style commendable to those who manage those companies. It was our intention to have given in this number a synopsis of them, with our annual comparative table, showing, at a glance, what each has done during the past year—but other avocations have prevented, and it is defered until the next number.

INDIANA RAILROAD REPORT.

We find in the Indiana State Sentinel of March 5th, the report of the Madison and Indianapolis railroad company, which we give at length, that our readers may know what is going on in the west. This report shows a very favorable and progressive state of affairs, and must stimulate those interested in the work to renewed efforts for its speedy completion. We find in this report a beautiful illustration of the advantages of *long*, over *short*, railroads. The rapid increase of receipts per week, when a new section of the road was opened for use, even though but a few miles in length, shows conclusively that as our railroad system is extended, and different roads are connected with each other, the business will increase almost in a geometrical ratio, and that roads which now scarcely pay expenses, will become profitable works, and good investments. We shall be gratified to record the completion of this road to Indianapolis, and *then* its continuance to Lafayette and lake Michigan. Accompanying the report is a statement showing the details of the freight transportation during the year.

To the directors of the Madison and Indianapolis railroad company:

One year having elapsed since the company took possession of the State's portion of the road, and since I have had the superintendance of all the affairs of the company, I deem it necessary and appropriate to lay before the board of directors as full a statement of the operations of the road, both as to transportation and construction, as circumstances will enable me and a proper understanding of the affairs and finances of the company may seem to require.

At the time the company took possession of the State's portion of the road and the consequent charge of the operations in transportation, the cars were running a distance of 28 miles, to Griffith's. Owing to the severe weather which continued to a late period in the spring of 1843, the road was not completed to Scipio until the 1st of June, at which time the cars commenced running to that point, being an extension of only three miles; at this point the northern terminus of the road continued until the 1st of September, a period of three months. On the 1st of September we extended the running of the cars to Elizabethtown, a distance of seven miles from Scipio, and ten miles from Griffith's. On the 1st of February we commenced running the cars to Clifty, being a further extension of 4½ miles, and to a point about 2½ miles south of Columbus, making an entire extension of the road complete, 14½ miles north of Griffith's.

The further completion of the superstructure to Columbus is in progress,

being so near completion as to secure the expectation that we may run the cars to that point in the course of the next two months.

Under authority of an order of the board, I contracted in August last with Mr. John McNickle, of Covington, (Ky.) for 180 tons of railroad iron, being a quantity, estimated sufficient to iron the road to Columbus. Of this iron, 110 tons have been delivered and mostly laid down. The balance, according to contract, is to be in readiness by the time the superstructure is prepared for it. For this iron, acceptances have been given for the first fifty tons, at 4 months—for the next fifty tons 6 months, and for the remaining portion at 5 months from the periods of delivery respectively. The acceptances have been made by drafts drawn by me, as treasurer of the company, on, and accepted and endorsed by gentlemen friendly to the road, who have lent their names to the company to aid in procuring the iron.

The progress of the contractors for building the superstructure between Columbus and Edinburg has been tardy, but not more so than could reasonably be expected. Considerable progress has, however, been made, and if some additional aid could be rendered by substituting more available means, we might hope to have the superstructure complete to Edinburg in the course of the next autumn.

The survey and estimate of that portion of the line of the road between Edinburg and Indianapolis, which was completed last summer, shows that the grading and bridging of this part of the road will cost much less in proportion to distance, than that portion south of Edinburg. The whole estimate for grading and bridging the 30 miles being only $96,500. The operations in the repairs of the road in use have been steadily in progress, but have been limited and confined to such repairs and improvements as seemed indispensable to the preservation of the embankments and superstructures, and such other work as was necessary to the successful operations on the road and the safe running of the cars.

This limitation was in a measure imperative from the necessity of meeting the company's obligations on paper given for iron, and on which various persons had kindly lent their names as security, and which every honorable consideration to them, and preservation of the credit of the company required should be promptly met. Had abundant means been at command, a more extended operation in repairs might with propriety have been gone into; but none has been neglected which a proper regard for the preservation of the road required. Much more has been done in this regard than had been performed the previous year while under the care of the State, and the condition of the road is as safe and favorable for the running of the cars and the general operations of its business as when the company took possession of it; and the preservation of the superstructure is much better secured, in that portion at least, which relates to the bridges.

A permanent depot has been completed at Madison, at a cost of nearly $1,200. Others of a cheap character have been provided by the lessors at Scipio and Elizabethtown, and a temporary one at Clifty, at the expense of the company; all of which have been necessary for the accommodation of the business of the road. The receipts from transportation and passengers have been favorable and have met my anticipations suggested to the board on a former occasion, although our charges on many articles of freight are too low. The receipts could not be expected to increase much while the road was unextended, and, indeed, as our charges were 25 per cent. below those charged by the State, it should not have surprised us if there had been a falling off in the receipts for the three months, and over, that we remained at Griffith's, but there has been a gradual increase in the business and re-

ceipts of the road; increasing greatly as it has been extended; the weekly receipts running up from $240 to near $1000, and the business accumulating beyond the means of our motive power to perform. The receipts for transportation and passengers for the 3½ months that our northern terminus remained at Griffith's, averaged $270 per week, and for the next three months while we were at Scipio, (an extension of three miles only) the weekly receipts averaged $400, and for the succeeding 5 months, our northern terminus being at Elizabethtown, (a further extension of seven miles,) the weekly average receipts were $550, and since we have extended the running of the cars to Clifty, a further distance of 4½ miles, we find that additional engines and cars are required to do the work, and our receipts running from 800 to over 1000 dollars per week.

This fully illustrates the certainty of greatly increased business as we extend the road into the interior. The ratio of increase in business will be equal to the square of the distance of each extension. These facts and considerations should, it seems to me, encourage the friends of the road and all interested, (and all on the line or within available distance of it, and all interior Indiana, are deeply interested,) to persevere in efforts to carry it through.

The total amount of receipts, exclusive of railroad scrip, from the 20th February, 1843, to the 3d February, 1844, have been $24,385 17 of which the sum of $22,110 33 were receipts from transportation.

The remainder were receipts on stock subscriptions and miscellaneous. The receipts for the unexpired portion of the year since the company took possession of the road will probably swell the receipts from transportation to $24,250.

At the period of our taking charge of the road, I signified my belief that the receipts from transportation would, with the other funds then on hand in State scrip, be sufficient to meet the demands against the company on the first iron contract, within one year from that date. This expectation has been fully realized, but the diversion given by the board to a portion of the receipts together with the necessity of paying for spikes, iron, freights, etc., has left a small portion of that debt yet unpaid; say about $1500, but a portion of this will still be discharged out of the receipts accrued within the year. There has been paid out of this fund set apart to meet this iron contract an amount larger than the unpaid residue of the iron debt. The contract with Col. McNickle for 180 tons of iron for extending the road to Columbus, will, including iron for spikes, call for the payment of about $11,000 to be paid on acceptances as suggested in a former part of this report, the means for which, I have no doubt, will be realized in the receipts for transportation in time for the maturity of the paper.

The required amount anticipated for the current expenditures for road repairs, cars, etc., will doubtless exceed, by a considerable sum, the outlays for the same purposes for the past year, but the greatly increasing business and consequent receipts from the road, it is presumed will cover such additional expenditure, except the purchase of an additional locomotive engine, which I deem indispensable, and respectfully recommend the board to authorize to be procured if means can be devised for its purchase.

I have, in pursuance of the order of the board, contracted with Messrs. W. N. Jackson and John D. Morris for the building of a suitable depot at Columbus; a duplicate of the article of agreement is on file in the office, and will be submitted to the board.

The main portion of the deeds given the company for lands subscribed, have been sent to the proper counties and recorded; an account of the expense of which will be submitted to the board.

I deem it due to the several officers in the service of the company, as well as the hands employed in the various departments, to testify to the industry and fidelity of each and all, and that during the great press of business for the last few months they have been subject to severe labor and exposure which they have gone through with cheerfulness and alacrity.

The greatly increased business of the road will require, without delay, some more efficient means of transportation over the plain at the Madison hill. The tardy and expensive mode now employed, together with the still more injurious results of delay, unavoidable in the present mode, render a change in this respect extremely desirable if not indispensable. The employment of a locomotive engine adequate to the business of the road, would save, in money and time, which is precious, an amount equal to its cost in a short time, besides other important advantages that would result from its adoption. The condition of the slip at the plain is not at this time safe for the use of such an engine, but this, however, could be placed in a suitable condition by the time the engine can be procured. The amount of debt contracted by the last purchase of iron will require the nett income of the road for the main portion of the year to discharge it, and of course no considerable amount can with propriety be calculated upon from that source for the purchase of an engine. But if the nett proceeds of the road for a period beyond the payment of the present iron debt, can by any means be anticipated, it seems to me that the engine should be ordered forthwith.

The remarkable weather which has visited us for nearly the whole time since the company has been running the cars, has been alike unfavorable to road repairs and to the business of the road, while its effects upon the embankments, cuts and foundations have been such as should be expected from the constantly wet condition of the earth.

This has been equally unfavorable to the running of the trains; the track being, much of the time, so slippery that the engines could not take over the road more than one-half to two-thirds of the tonnage that can be taken in favorable weather. Yet with all these difficulties an amount of business has been done (as will be seen by the tabular statements) far beyond any previous year, and repairs have been made also to a larger amount.

With obstacles thus difficult and opposing, and with a tariff of charges, on an average at least 25 per cent. below that charged by the State, the receipts from transportation for the year ensuing the time of our taking possession of the road will have amounted to rising $24,000, not in outstanding and unavailable debts, but in actual cash receipts. The nett proceeds of the road, after deducting the rent to the State, will not vary much from 10 per cent. on the capital stock of the company paid in; which amount will be subject to division among the stock, to be carried to the credit of the stockholders as so much additional stock, agreeable to the consent in writing of most of the stockholders on file in the office, or to remain as a surplus to be hereafter divided

But if the board should deem it advisable to declare a dividend, I would recommend that it should not exceed 8 per cent., leaving an overplus for future disposition.

Statements will be exhibited to the board for its information, showing the general state of our finances, and the amount of receipts and disbursements under each appropriate head, together with tables showing the state of my account with the company as its treasurer, to which I invite a searching scrutiny by the board.

Believing the taking proper care of money when earned, as important as to earn much, I have carefully watched the operation of our system of ac-

countability, and checks, and balances, and have examined the waybills and collated and compared the results with the weekly statements of the clerks of transportation and conductor, upon which these payments are made to the treasurer, and find that the system, though not perfect, is, if fully carried out, sufficiently guarded for the protection of our funds, and which is further secured by honest and faithful officers, having charge of the departments of transportation.

This being the first year of the company's operation in transportation and control of the road, much interest has been manifested by the stockholders and the public as to its management and probable results which would flow from an extension of the road, both as to its own revenue and utility to the public. The practical illustrations which have resulted from this one year's experiment, in our system of management, accountability and economy, together with the certain favorable effects of the extension of the road on its business and revenue, should be highly gratifying and encouraging to all the friends of the road; and although this great undertaking (so far as the company is concerned,) is in its infancy, yet we have good reason to hope that the ultimate results will be alike propitious in profit to the shareholders and general utility to the community.

In the management of a business so large as is now commanded by this road, and where every interest, so far as regards the details of its management, is antagonistical to the interest of the company—added to the fact that some delight in, and are incessant in manufacturing clamor, it could not but be expected that complaints would be made; but so far as these several conflicting interests have depended upon my action, I have carefully consulted my best judgment, and when convinced of the right and proper course, I have carried it out, as I hope, with firmness and moderation, and hold myself responsible to the board and to the stockholders for my action as their agent and representative. All of which is respectfully submitted.

Madison, *Feb.* 22, 1844. N. B. PALMER, *President.*

The following table will show the amount and quantity of the several articles of freight (inward bound) or going south, which passed over the railroad from the 20th of February, 1843, to the 3d of February, 1844. A statement of the outward bound freights, together with other interesting tables, will be shortly published, but which are not at this time in perfect readiness.

2,340	through passengers,	1,328	flour barrels,
2,974	way "	31½	bushels barley,
402	hhds. bacon,	87½	bushels grass seed,
243,763	bacon and bulk pork,	20,324	hoop poles,
15,038¼	bushels wheat,	489	bushels potatoes,
5,570	bbls. flour,	18	head cattle,
260,918	lbs. miscellaneous freight,	281	head horses,
1,382½	bushels flaxseed,	256	bbls. whiskey,
1,956	kegs lard,	2,211	pork barrels,
1,157	bbls. lard,	23,277	pounds furniture,
1,981	bbls. pork,	868	lard kegs,
1,153	cords wood,	325,286	feet poplar lumber,
210,692	pounds hay,	4,535	feet ash and cherry do.,
17,376	live hogs,	92	car loads staves,
483	slaughtered hogs,	11	perch stone,
11	bushels corn,	89½	thousands shingles,
43,838	pounds hemp,	365	bacon hhds.,
254,306	pounds tobacco,	18	carriages,
158	bushels meal,	757	bushels oats.

The following description of preparing the speculum for a large telescope will be found interesting to many of our readers. It is taken from the February number of "The Civil Engineer and Architect's Journal."

LORD ROSSE'S TELESCOPE.

At a meeting of the Belfast Natural History Society, the steps by which difficulties were overcome in making the speculum, were explained by Mr. Stevelly in detail, under the following heads:

METAL FOR THE SPECULUM.—The metallic alloy for the speculum consists of four atoms or chemical combining proportionals of copper to one of tin, or by weight 126·4 copper to 58·9 tin. This alloy, which is a true chemical compound, is of a brilliant white lustre, has a specific gravity of 8·811; a twelfth of a cubic foot, or 144 cubic inches of it, weighing, therefore, a little over 45¾ lbs. avoirdupoise, or to allow for all waste when casting, 50 lbs. which is the rule by which Lord Rosse estimates the weight of metal he requires. This alloy is nearly as hard as steel, and yet is almost as brittle as sealing wax. Of this most unpromising material Lord Rosse has cast, ground, and has ready for polishing, a circular mass, 6 feet in diameter, 5½ inches thick, and weighing upwards of three tons, with a surface perfectly free from crack or flaw, and quite homogeneous. The next head is

CASTING.—On the first castings having flown into pieces, finding that the fragments no longer fitted each other in their former places, he perceived that they had been in a state of violent strain arising from the cooling and setting of the outer parts, while the inner parts, yet fluid, were also largely expanded by the heat; this, and the porous surface, led him by many stages and trials to the remedy, which is simple and complete. The bottom of the mould is made of a ring of bar iron, packed full of slips of iron hoops set on their edges, which lie in parallel cords of the ring. These, though packed very tightly together, and so closely fitting that the melted metal cannot run between them, yet allow any air that is carried down to the bottom of the mould when the metal is cast in, to pass out through the interstices. After the ring is packed, it is secured in a lathe, and the face, which is to be the bottom of the mould, turned true to the convex shape to fit the concave speculum required. It is then placed flat on the ground by spirit levels (between the surface in which the metal is melted, and the annealing oven,) and the mould completed at the side with sand, in the way practised by founders, but left open at the top. The metal is then melted in cast iron crucibles; wrought iron would be corroded by the speculum metal, and injure its properties, while fire clay crucibles will not answer. Unless the crucibles be cast with their bottoms downward, they will be porous, and the metal alloy will run through their fine pores. When the metal is melted, and still much too hot to pour, the crucibles are brought by a crane, and set firmly, each in a strong hoop iron cradle, which turns on gudgeons, and so arranged round the mould that when the handles of the cradles are depressed, they pour out their molten mass direct into the mould. An oxide forms rapidly on the surface of the metal while too hot—this is as rapidly reduced back to the metallic state by constantly stirring it with a pine rod; as the temperature sinks, the instant this reduction of the oxide begins to cease, is seized on as the proper moment for pouring. The liquid mass descends with a few fiery splashes, and after waving back and forward for a few seconds, the surface becomes still. The setting process begins at the hoop iron bottom, where a thin film first sets—the process extends upwards in horizontal layers, and at length the top, though red, becomes fixed in form; the mass is then as tough as

melting glass, and being turned out of the mould upon a proper truck, with the face upwards, is drawn into the oven to undergo the process of

Annealing—or very slow cooling. Here it is built up into the oven, previously heated red hot, and fire is kept up under the floor of the oven for some days; the under fire places are then stopped, and all left for weeks to cool down to the temperature of the air. The six feet speculum was left here sixteen weeks. Here the particles of the alloy slowly arrange themselves into the arrangement in which the aggregating forces are in equilibrium, or natural and equal antagonist tension. When the oven is opened, the speculum is removed to the workshop, to undergo the process of

Grinding—which process was illustrated by working a model. In the workshop it is placed on a circular table, in a cistern filled with water, of temperature, say 55° Fahrenheit, with the face to be ground upwards. The circular table is turned round by the motion of the grinding engine. But first, the edge is made truly cylindrical by being surrounded by many pieces of deal board set in an iron ring pressing against the edge; emery being introduced as it turns round, soon grinds it cylindrical; it is then placed in the box in which it is to be used; here it is firmly secured by a ring of iron brought to embrace, firmly yet gently, its now truly cylindrical edge. The box and speculum, with the face to be ground placed upwards, is now again placed on the circular table in the cistern of water. Emery and water being placed upon it, the grinding disk is laid on, which is a cast iron plate turned at one surface to the shape to fit the speculum when ground, and grooved on that surface with many annular grooves concentric with the plate, and with many straight grooves running across at right angles to each other. The back of this grinding plate is ribbed with six or eight radial ribs, to give it stiffness. This plate sits rater loosely in a ring of iron a little larger in diameter, which is driven back and forward by the motion of the steam-engine. This ring has two motions, longitudinal and transverse. The engine causes it to make 24½ strokes for one turn of the speculum on its axis under the grinding disk, about 80 strokes taking place in a minute; the length of this stroke is one-third of the diameter of the speculum. The motion is produced by an eccentric pin. The transverse stroke takes place 1·72 times for each turn of the speculum, and its extent is, at the centre of the speculum, $\frac{27}{100}$ of the diameter of the speculum; it is produced by an eccentric fork. A fourth motion takes place by the grinding disk, while for an instant free of the ring, at the turn of the eccentrics, being carried round a little by the speculum, on which it is then lying as it were free; this causes it to turn once for about 15 turns of the speculum. Emery and water being constantly supplied, the surfaces of the grinding disk and speculum in a few hours grind each other truly spherical, whatever be their original defects of form. The process is finished, when, upon drawing off the grinding disk with one steady long pull, the surface of the speculum is left every where uniformly covered with the fine emery arranged in uniform lines, parallel to the line in which the disk was drawn off. A slight polish being now given to the speculum, its focal length is tested by a very simple process. The floors of the loft above the workshop, in the tower of the castle, contain trap doors, which are now opened, and a mast erected on the top of the tower, which carries at its top a short cross arm, to the under surfare of which a watch dial is fastened, the face of the dial looking down on the speculum, now directly under it, and at a distance of 97 feet. A temporary eye piece erected in the upper floor of the tower, soon finds the place of the faint and still imperfect image of the watch dial, the proper place of which is a matter of simple calculation, if the speculum be ground to the expected focus.

If it be found incorrect, the grinding disk is rendered a little more flat, or a little more convex, and the grinding process is renewed, and so on, until the spherical face of the speculum is given its proper length of radius. When this is accomplished, the brilliant reflecting surface, and true form for producing a good image, is given to the speculum by the final process of

Polishing.—In this, two matters require attention, the polishing powder and the surface of the polisher. The powder used by Lord Rosse is not putty or oxide of tin, as used by Newton and his followers, but red oxide of iron procured by precipitation from green vitriol or sulphate of iron by water of ammonia; this is to be heated carefully in an iron crucible, for it has a tendency to take fire, and thus run many particles into one, and render the polishing powder too coarse. The surface of the polisher used by Newton was pitch in a very thin layer. Instead of pitch, which Lord Rosse found too full of gritty impurities, he uses resin tempered with spirit of turpentine. A large quantity of resin being melted, the spirit of turpentine is poured in, and well mixed and incorporated (about a fifth by weight suffices.) The proper temper is known by taking up a little on an iron rod, and putting it into the water until it acquires the temperature, say of 55° Fahrenheit. Then if the thumb nail make a slight but decided impression, it is rightly tempered; if not, more resin or more spirit of turpentine is added, until the proper temper is attained. The tempered resin is now divided into two parcels; to the one parcel a fourth part (by weight) of wheaten flour is added to give it tenacity and diminish its adhesiveness. This is incorporated by stirring until it becomes clear. To the other parcel an equal weight of resin is added, which makes it very hard. Upon this, when cooled to 55°, the nail will scarcely make an impression. The grinding disk, with its spherical surface turned upwards, is now heated by fire underneath, and the resin rendered tenacious by flour laid on with a brush in a thin even coat about 150° Fahrenheit. This coat and the grinding disk are then allowed to cool down to about 100° Fahrenheit, when a thin coat of hard tempered resin is laid on as evenly and thin as possible. The smooth ground concave speculum is now covered with a creamy coat of the fine polishing powder and water, and the warm polishing surface turned down upon it at about 80° Fahrenheit, when it soon takes the form of the speculum as in a mould; care must be taken not to put on the polishing plate too hot for fear of cracking the speculum, which the interposed creamy polishing powder helps to protect; nor too cold, else it will not take the proper figure. The grinding engine now gives the same motions to the polishing plate as before, but its weight is much diminished by counterpoising it. The soft tenacious coat below, and the grooves on the surface of the grinding disk, permit the proper lateral expansion, while the hard outer coating retains its form, and holds firmly embedded the particles of polishing powder. The polishing now proceeds rapidly, and as soon as what is technically called the black polish is attained, the defining power is judged of by examining the minute divisions of the image of the watch dial under an eye piece of high power. The true form is known to be given as the polishing proceeds, if the focal length slowly increases in a tabulated proportion to the time. The six foot speculum it is expected will be finished after six hours' polishing.

An Enormous Steam Engine—by far the largest ever constructed—is now in process of manufacture at Harvey and Co's. foundry, Hayle; the piston rod, which was forged last week, is 19 feet long, 13 inches diameter in the middle, and 16 inches in the core; and weighs 3 tons 16 cwt. It will work in an 80 inch cylinder, which will stand in the middle of another cyl-

inder, of 144 inches diameter. Five other piston rods will work between the inner and outer cylinders. We conclude, for this has not been explained to us, that the piston of the external giant cylinder will be perforated in the middle for the 80 inch cylinder to stand in it, and will work between the two. The 80 inch cylinder was cast last week, and the large one will be cast soon. The pumps are to be 64 inches in diameter; a measurement which may afford some idea of the size of the engine. It is intended for draining Haerlem lake, in Holland, and it is expected that other orders for similar engines will be received from the same quarter. It is truly gratifying to us to observe that Cornish engineers still keep so far in advance of all the world, and not less gratifying to see that foreign powers know and can appreciate their excellence. Let this wonder of engineering and mechanical skill be considered, as well as the duty done by our common mine engine; and it must be confessed that our Cornish mechanics are, in this branch, far in advance of every competitor; and we may reasonably hope, as superior merit must be appreciated at last, that our engine foundries will at length have their full share of public and government patronage.

Bothway's Iron Blocks.—An experiment has been made in Plymouth dockyard, to try the comparative strength of Mr. Bothway's single metal blocks against the rope it is calculated to take, viz., a 3 inch one. A rope of that size was rove in the block, and one end brought to a windlass, and hove on until it broke. A 3½ inch was then tried; though larger than required for such a block, this also gave way; and the last is considered by practical men fully equal to the powers of an 8 or 9 inch block. The iron blocks have also another great recommendation in doing away with the rope strappings, as many serious accidents have occurred by their breaking.—*London Mech. Mag.*

Street Sweeping by Machinery.—The first exhibition in the metropolis of the self loading cart, or street sweeping machine, which has for some time been in use in Manchester, and is fully described in the "Mechanics' Magazine," No. 1014, took place recently on the wood pavement in Regent street, and attracted crowds of persons to view its very novel apparatus. The cart was drawn by two horses, and attended by a driver, and as it proceeded caused the rotary motion of the wheels to raise the loose soil from the surface of the wood, and deposite it in a vehicle attached to the cart. Proceeding at a moderate rate through Regent street, the cart left behind it a well swept track, which formed a striking contrast with the adjacent ground. It filled itself in a space of six minutes, its power being equal to that of forty men, and its operation being of a three fold nature—that of sweeping, loading and carrying at the same time, which under the old process formed three distinct operations.—*Ibid.*

A Handsome Present.—The little steamer built by Mehemet Ali to send as a present to the Sultan, is a most splendid little vessel, furnished in a most costly style. The cabins are entirely built of rosewood and mahogany, with silver columns, and rich satin curtains covered with gold. She is schooner rigged, and the masts are all of solid cherry wood. The engines are of thirty-six horse power, and there is no doubt that she will be a most acceptable gift to the Sultan as a pleasure yacht.—*Herapath's Journal.*

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WEAR AND TEAR, AND DESTRUCTION OF IRON RAILS.

We had hoped that ere this we should have received from some of our correspondents a review of Mr. Ellet's communications on "the cost of transportation on railroads." In these there is much in which we concur; but there is, on the other hand, so much of error mixed up with the truths that they contain, that it is extremely desirable that some practical engineer, who has constructed and managed *railroads*, should review them, and inform the readers of the Journal, many of whom are large stockholders in their undertakings, where the views taken in Mr. Ellet's papers are correct, and where erroneous.

On one point it seems to be generally conceded that Mr. E. has adopted most exaggerated views. We mean in relation to the wear and tear and destruction of iron rails. This has been hitherto much greater *apparantly*, than it is *really*, from the disposition of railroad companies, both in England and America, to progress in the improvement of their superstructures with the increase of their business, which has led them often to substitute a heavier rail for a lighter, long before the latter had given out, and in some cases even before it was materially injured. It is obvious, however, that whatever may have been *hitherto* a fair allowance for the wear and tear of iron, a very small one comparatively will be sufficient *hereafter*, for the following reasons:

1st. The value of *slow motion* for freights is now beginning to be generally understood, and the wear and tear and destruction of rails, occasioned by the passage of a train over a railroad, is much more than proportionally diminished with every diminution of speed.

2d. The locomotives now being introduced for freights, with much more adhesion, and, in consequence, much more capability than the old, have their weights more equally diffused, and *less on a single pair of wheels* than the old, and the motion of a train over a road, drawn by such a locomotive, is, therefore, much less injurious.

3d. While by the use of these effective, but slightly oppressive machines, at slow motion, the passage of a train over a railroad is much less injurious than it formerly was, inasmuch as the injury to the rail (that arising principal-

ly from the passage of the locomotive and not of the cars,) is but little more for a long than a short train, the amount of injury *per ton* conveyed is still farther diminished compared with what it has been, *in consequence of the increased length of trains.*

For the above reasons it is obvious that Mr. Ellet's calculations, as to the wear and tear of railroad iron, per ton conveyed, deduced from roads on which high speeds, engines with great weight on a single pair of wheels, and short trains, are run, must necessarily be immensely exaggerated, when applied to the Reading railroad, on which, if we are correctly informed, 8 wheel engines, at a moderate velocity, draw trains averaging 160 tons nett, and on which, it is believed, that engines of the same weight with those now employed, so constructed as to have the benefit of their whole adhesion, and with the weight equally divided on all the wheels, (so as to have but little more weight on a wheel than the weight on an ordinary car wheel,) may draw 800 tons. With such engines, and we have no doubt they will be ere long introduced on the Reading and other roads, the iron of railroads may be expected to last as long, with slow transportation on locomotive as on horse power railroads, and on the latter the wear of a well made *edge rail* may be considered so small an item, as to be scarcely worthy of consideration.

We have designed in the above remarks only to advert to the subject noticed in them, by way of inviting the attention of some intelligent and practical professional gentleman to it, and to the other elements of the cost of transportation on railroads considered in Mr. Ellet's communications. We have indeed to regret that those members of the profession of civil engineers who could do most to enlighten the public mind on subjects connected with their profession, have but rarely listened to our appeals to them. We shall continue to hope, however, that this may be more the case hereafter than it has been heretofore, and that those whose experience is greatest in their profession may be willing occasionally to present through our columns their views on important professional subjects in relation to which it is desirable that the public mind should receive correct impressions.

BALTIMORE AND OHIO RAILROAD—TRANSPORTATION OF HEAVY FREIGHTS.

Through the politeness of B. H. Latrobe, Esq., chief engineer, we have received a pamphlet, entitled "Two replies of the Baltimore and Ohio railroad company, to interrogatories propounded to the said company by the house of delegates of Maryland." The main object of the inquiries appears to have been to ascertain the *rates per ton* at which "the railroad company would engage to transport coal, iron, etc., from Cumberland to dam No. 6, provided an arrangement be made for such transportation to last for two, and also for twelve years, or permanently." To these, and other inquiries, the company replied, under date of 1st February, 1844, as follows, to the 1st and 3d inquiries—the answer to the 2d, 4th and 5th are here omitted, as the whole subject is fully answered in the reply of the company,

through their able president, Louis McLane Esq., in answer to a second call from the house of delegates, which, with the accompanying estimates, and statements, we give at full length.

1st inquiry. What is "the lowest rate of toll per ton per mile at which the company would agree to transport *coal*, *iron*, etc., from Cumberland to dam No. 6, etc.

"1st. That, provided a satisfactory arrangement be made within the ensuing twelve months, for the transportation of not less than 105,000 tons of coal annually, in equal daily quantities, during the canal season, assumed to be 250 days, from Cumberland to dam No. 6, to continue for twelve years or permanently, this company will engage to transport that amount, or any greater quantity not exceeding 500,000 tons as aforesaid, between those points at 1⅓ cent per ton per mile."

2d Inquiry, Requests a "statement of the relative cost of transportation by means of the railroad and canal from Cumberland to Georgetown, and by the canal alone, if finished," to the latter place.

"3d. That this company decline to assert positively the lowest cost of transportation by the canal alone, if finished from *Georgetown* to *Cumberland*, but assuming such cost to be, as stated in the report of the canal company of the 16th of November last, $1\frac{254}{1000}$ of a cent per ton per mile, the relative cost of transportation by means of the railroad from *Cumberland* to dam No. 6, and thence by canal to *Georgetown*, and by the canal alone, if finished from the same to the same, will appear as follows:

"Tolls and charges on railroad to dam No. 6, 45 miles at 1⅓ cent,	60
"Tolls and transportation on the canal from dam No. 6 to Georgetown, 136 miles at $1\frac{254}{1000}$ cent per mile.	1 70½
	$2 30½
"The cost of transporting a ton of coal from Cumberland to Georgetown by the canal alone, 184½ miles, at the above rate of $1\frac{254}{1000}$ cent per ton per mile,	$2 31"

From the estimates here given, which have unquestionably been made with great care, it will be seen that heavy freights may be carried on a railroad at very low rates, and at a fair profit—where the trade is regular and certain.

These "replies" are from practical men who have been long in the school of experience—and will be, by many, deemed conclusive answers to Mr. Ellet's theory in relation to the wear and tear of iron rails.

Office of the Baltimore and Ohio railroad company,
February 15th, 1844.

To the honorable the speaker of the house of delegates:

Sir: I had the honor to receive on the 12th inst., the order of the house of delegates passed on the 10th, and having at the earliest day practicable submitted it to the board of directors of this company, I am authorized to transmit the following reply.

In the first place, the board desire it should be distinctly understood that the investigation into which the house of delegates have been led, has been without their prompting or knowledge, and that in responding to inquiries into their resources and business, which, by exposing in detail the course and results of a single branch of their operations, may possibly lead to erroneous inferences in respect to others—without a like opportunity of explana-

tion—they yield only to a sense of respect due to the legislature of the State having so deep an interest in the trade and revenues of the road. The sequel of this present answer will satisfactorily show that the board need have no other objection to the amplest exposition of their credit and resources, and of the whole range of their transactions, on any other ground than that already indicated.

The board have at no time heretofore deemed it expedient or desirable to make expensive preparations for the transportation of any considerable amount of coal from the mines in Allegheny county. It has been quite obvious to them, as indeed they must presume it will be to all, that without the facilities of railroad communication between the mines and Cumberland, the article could not be brought to the latter point in quantities sufficient to warrant a large expenditure in providing means of transportation by any channel whatever. Up to this period the ultimate route of the Baltimore and Ohio railroad from Cumberland to the Ohio river is too indeterminate to authorise any attempt to extend it to any part of the coal region, and it is only recently that the board have seen any evidence of the existence, in any other quarter, of the capital sufficient either to construct a road to the mines, or to develope, except in a partial degree, their resources. It would be manifestly unwise in this company, or, as it may be presumed, in any authority whatever, to venture upon a large expenditure to acquire the capacity to accommodate a particular branch of trade, without at least some reasonable assurance that after the capacity should be acquired, sufficient trade would exist to employ it; and this consideration is particularly applicable to the operations of the railroad, inasmuch as the greater part of the preparations necessary for the transportation of coal would not be needed, and could not be advantageously employed in any other business.

This board, moreover, after thorough investigation of the subject in all its bearings, have placed no great confidence in the expectations founded upon the rapid and extensive developement of the coal of that portion of the State. If the requisite capital for the purpose can be commanded, they have been unable to discover any evidence that the demand for consumption will be such as to authorize, on their part, at least, any great preparations for engaging in the trade. They have become convinced, on the contrary, that many years must elapse before the demand will require more than 100,000 tons in any one year, whatever facilities of transportation may be afforded. It is to be observed also that to justify the railroad company in engaging extensively in the transportation of coal, at such rates as would bring it to market upon equal terms with coal of other States, it would be necessary that the trade should be large in amount, and of certain and regular supply throughout the year; of which, up to this time certainly, there has been no satisfactory assurance. Of the capacity of the company, with those advantages, to engage in the transportation of coal, at rates extremely profitable, and at the same time so low as to exclude the apprehension of rivalry from other works—according to any rate of charge at present known—the board have never doubted. The estimates accompanying this answer, and the large margin of profit which they exhibit upon the terms assumed, will show that if the board would be content with a nett profit of six per cent. upon the capital employed, it has the capacity to engage in the trade from the mines to the city of Baltimore at rates below any other mode of transportation at present known. The indisposition of the board, therefore, heretofore to engage in the transportation of coal, has proceeded from no other apprehension than the want of certainty and regularity in the amount; and on this ground they have preferred waiting events, and to test the practicability of develop-

ments so confidently predicted by others; with entire confidence, at the same time, that if those expectations should be realized and the trade in coal become sufficiently regular and certain, they could, at any time, engage in the transportation of it to Baltimore without danger of serious competition with any other rival.

Previous to the order of the house of delegates of the 25th of January, however, the board were officially informed by the president of the Maryland and New York iron and coal company, that he had procured the requisite funds for the construction of a railroad from the works of that company to Cumberland and was anxious for the completion of the road in the shortest possible time. The same officer also verbally communicated his desire to adopt the Baltimore and Ohio railroad to Baltimore for the transportation of coal and iron, if this company would engage in the trade at such rates as would enable him advantageously to do so. The investigation to which this application led only confirmed the opinion of the board that they might engage in the transportation with great advantage to the stockholders, and upon terms which, considering the speed at which they could perform the business, and the superiority of the Baltimore market, he might be well content to accept. Under such circumstances, they felt an obligation not to withhold their aid from the development of the resources of that important region. The order of the house of delegates of the 25th January, therefore, came while investigations into the practicability of arrangements for this purpose were actually in progress. A few days subsequent to the answer of the board to that order, the president of the Maryland and New York iron and coal company submitted a further and specific proposition; and it may be proper to remark, that in this proposition that company, of acknowledged means and capacity, does not appear to contemplate a greater amount of transportation than 52,500 tons per annum for a period of five years, and that not of coal only, but of "coal, pig iron, bar iron, fire bricks, castings, and other manufactures of iron." The object of the proposition was to ascertain the terms upon which this board would transport that amount *from the mines to Baltimore*, if the Maryland and New York company would make a railroad from the mines to the depot at Cumberland, and enter into an agreement for five years to furnish a freight, for one train of cars, supposed to transport 175 tons per day for three hundred days in the year.

In answer to the proposition, this board have offered to enter into an engagement to transport that amount of freight, in the manner proposed, from the mines to *Baltimore*, at one and one-third cent per ton per mile, a distance of 188 miles, with ten cents per ton for transportation through the streets of Baltimore; and one cent per ton per mile for 188 miles in addition upon manufactured iron, when required to be transported in house cars; the Maryland and New York company to load and unload the cars. An official estimate, forming the basis of this offer upon the part of the company, and showing the results of the operation, is herewith submitted, marked D.

I have now to add that since the preparation of this reply, a communication has been received from the president of the Maryland and New York iron and coal company, announcing the acceptance by that company of the foregoing offer; and stating his readiness to conclude a formal agreement to carry out the arrangement.

With these remarks, which have been deemed proper for a full understanding of the whole subject, I proceed to a more particular reply to the several questions propounded in the order of the 10th instant.

1st. The terms "satisfactory arrangement," in the answer of the board of the 1st instant, are to be understood to require a reasonable assurance that

the amount of transportation for which the company would be compelled to qualify itself, should in good faith be furnished; and with such regularity and punctuality, during the period assumed, as would authorize the board to engage in it at the low rates proposed.

If such reasonable assurance could not be given by those who are interested in the trade, and who are seeking the means of reaching the market, it is not perceived upon what grounds they can with propriety demand a large expenditure of money for the preparation of any means of transportation.

It has already been remarked that without a railroad communication from the Frostburg mines to Cumberland, it is obviously impossible that the resources of the former can be sent forward in quantities to justify any considerable preparation of any kind; and it is not to be supposed that these works will be constructed until the market shall demand an adequate supply, and the capital be provided to meet such supply. As the basis, therefore, of any "satisfactory arrangement" contemplated in the former answer, the board would require,—*First*, that the necessary communications from the mines to Cumberland, should be constructed; *Second*, that adequate capital for working the mines to the proposed extent should be provided; and *Third*, that responsible parties, engaged in the business, should enter into an agreement to furnish the requisite amount upon the terms and in the manner proposed. The board would take it for granted that responsible parties would not perform these things without a reasonable certainty that they would find a market for the products of their labor and capital; and until they can have such certainty they would not be justified in demanding extensive and unnecessary expenditures, of which they could not avail themselves.

2d. For the charge of 1½ cent per ton per mile, as specified in their answer of the 1st instant, the board contemplates a ton of 2,240 lbs.

3d. In reply to this answer, and in illustration of other parts of this answer I herewith submit a report and estimate of the superintendent of machinery and repairs, approved and confirmed by the chief engineer of the company, marked B. From this it will appear that to provide the necessary "conveyances, cars and machinery, to accommodate a trade of 105,000 tons, annually, between Cumberland and dam No. 6," it will require the sum of *eighty-seven thousand dollars*, and for additional sideling tracks at dam No. 6, *three thousand dollars*, making together *ninety thousand dollars;* and "for the accommodation of 500,000 tons, annually, between the said points," it would require $450,000, including, of course, the previous sum of $90,000.

4th. Under other circumstances, it might be a sufficient reply to the question to state that the company expect to derive the means to enable them to engage in the transportation they have contemplated, from those sources from which all railroad companies derive the means of maintaining their works and carrying on their trade; and that this board is quite incapable of venturing to engage in any branch of trade, without a just reliance upon their ability to fulfil their engagements. Upon the present occasion, however, the board desire to give a more particular answer.

In their annual report of October, 1842, the board stand pledged not to apply any portion of their annual revenue to the extension of the road west of Cumberland, without at least the consent of the stockholders; and, adhering to the determination to prosecute their work with the least possible delay to the Ohio river, they would deem it unwise to use any part of their fund appropriately applicable to the extension of the road, for the purpose of increasing their machinery for the accommodation of trade from the present terminus.

The trade upon the Baltimore and Ohio railroad, however, is obviously on the increase, and in the course of the next year may require some augmentation of its machinery for the accommodation of the regular and accustomed business. For this purpose, and for any new trade in which the board may decide to engage, the ordinary and legitimate resources are the *credit* and *revenue* of the company. From one of these the capital needed for the contemplated transportation of coal must be drawn, and that either will prove entirely adequate, is not to be doubted.

Of the solidity of its credit, this company has just reason to be proud; and they have the gratification to know that under its financial arrangements, the improved economy in its operations, and the continual increase in its business, its credit is daily becoming better entitled to public confidence. It has, at all times, promptly complied with its obligations to the State, and to individuals; its ability in the future is not less than in the past; and its bonds now outstanding for the debt incurred on account of the Washington road, are in demand in the market at a premium of five per cent. If it may be assumed that capitalists will be found to advance the requisite funds for working the mines which are to yield the coal for transportation, and for the construction of the roads necessary for its conveyance to Cumberland; or if it be probable that the same facilities may be found to raise the millions requisite to provide other channels of conveyance, not merely dependant upon the developement of the trade, but in competition, as the estimates herewith submitted show, with a work in full operation, capable of transporting at as low a cost; the ability of this company to raise, upon its credit, some addition to its revenue, to be employed in a business certainly yielding a nett annual profit of not less than 20 per cent., will scarcely be deemed less probable.

The revenue of the company, should it be proper to use it, presents a resource equally available.

The nett revenue of the last year amounted to nearly $280,000, and enough is already known to authorize the presumption that for the present it will not be less than $300,000. Hence it will be clear, from the estimate already referred to, that to accommodate a coal trade of 105,000 tons per annum, from the mines to dam No. 6, little more than *four months* of the nett revenue will suffice; and that for the same amount of transportation from Cumberland to dam No. 6, a much less sum will be adequate. It is to be remarked also, that upon either amount, should it be drawn from the revenue, the stockholders will annually receive nearly 20 per cent. from its new employment, and one-third per cent. upon the entire capital of $7,000,000.

Whether the board will resort to its credit or to its revenue, will depend upon the best view they may take of the interest of the stockholders, when it may become necessary to resort to either.

The conviction entertained by the board, of the progress and amount of the contemplated coal trade, if the supply for consumption should immediately require the transportation of 105,000 tons in one year, they are quite confident that after reaching that amount, whenever that may be, the annual increase from that time, may be accommodated from the profits derived from this branch of trade. It may well be supposed, that no one can be found so sanguine as to imagine that the consumption of this coal will at the end of eight years require the annual transportation of more than 500,000 tons; and upon this hypothesis, the statement herewith submitted, marked C, will show that the transportation of such amount at that period, as well as previous thereto, will be maintained by the profits of this single operation, without further recourse to the revenue or the credit of the company. If, however, the board should, in any degree be disappointed in these expectations

—which they by no means apprehend—the deficiency, small as it must necessarily be, may be readily supplied from either of the sources already indicated.

5th. In reply to this question also the attention of the house of delegates is particularly requested to the estimates already referred to, and marked B; which were taken as the basis of the previous answer of the board of the 1st instant.

These estimates and the expenses of transportation are in every instance derived from the *actual experience*, not only of other companies but of this company; an experience in our operations of many years, and from their uniformity, and the economy we have been enabled to introduce, all estimates founded upon them possess, in all our calculations, the most satisfactory authority.

It is to be observed also that the principal means by which we are enabled to engage in the transportation of coal at the low rates referred to, are found—1st, in the use of the approved heavy engine, possessing nearly triple the capacity of those formerly, and now in use by the company—2d, in the comparative cheapness of the description of cars, and the less weight they are required to have in proportion to the load they carry—and, 3d, in the amount and regularity and punctuality of the trade.

It may therefore be stated, that from Cumberland to dam No. 6, a distance of 45 miles, the cost per ton per mile of transporting 105,000 tons in 250 days of canal navigation, is estimated at $\frac{841}{1000}$ of a cent. If the charge be $1\frac{1}{4}$ cent per ton per mile, the nett profit will be $\frac{392}{1000}$ of a cent per ton per mile; and upon 105,000 tons transported 45 miles, or 4,725,000 tons carried one mile, it would be $18,522, being upwards of 20 per cent. upon the capital employed, and more than one per cent. upon the entire cost of the road of 45 miles used for the transportation. Upon the same quantity transported from the mines to dam No. 6, and requiring a capital of $102,000, the nett profit would be $23,215, being nearly 23 per cent. upon the capital employed.

It will also be observed that the expenses of transporting 105,000 tons of coal from Cumberland to dam No. 6, include interest at 6 per cent. upon the whole cost of machinery employed in it, as well as every other item of cost arising out of the trade; and the estimate also allows one-fourth of a cent per ton per mile for the increased wear and tear of the road due to the accession of the additional trade. Regarding this specific transportation between the said points as no part of the general trade of the road, upon which all the present expenses of working it are charged, it was deemed unjust to charge the new trade with any part of the expenses already incurred, and which would continue, although the additional trade should not be undertaken; and, therefore, it is not doubted that one-fourth of a cent per ton per mile will prove ample allowance for the additional wear and tear it is intended to cover.

In any view, therefore, whether we regard the investment of the additional capital in the machinery alone, or in that and the road together, it is presumed that the transportation proposed will be considered "*profitable.*"

6th. At two cents per ton of 2240 lbs. per mile, the company would be willing to transport coal from Cumberland to dam No. 6, at all times, without requiring a stipulation that it should be delivered in equal daily quantities; and would be willing to "increase its machinery for that purpose according to the growth and requirements of the coal trade;" provided such trade between those points shall be equal to 50,000 tons per annum, and the company not be required to transport more than 420 tons in one day. Or, if the trade should amount to 100,000 tons per annum, the company would

transport it in the same manner, and at the same rate not exceeding 840 tons per day.

7th. Since the opening of the road to Cumberland, in November, 1842, the rate for the transportation of coal has been two cents per ton per mile; and until there should be greater facilities for its conveyance from the mines to Cumberland, the company did not increase its machinery for the accommodation of this trade. The whole quantity of coal, other than that for the use of the company, taken from Cumberland upon the railroad to all points amounted to 5625 tons of 2240 lbs.; and all that was offered for transportation was not invariably carried when presented. There was occasionally also, "delay when other tonnage was seeking transportation." This was the consequence of an insufficiency of machinery to transport all articles offered for that purpose; and when it became necessary to choose between different articles presented at the same time, such as were perishable or most valuable, were preferred. Such, moreover, was the irregularity in the delivery of coal as to render its prompt transportation in many cases impracticable, even if the company had been better prepared for the trade. The limited means, during the past year, for the transportation of coal, was well known to the dealers in that article, who without any expectation of its immediate transportation, must have delivered it with full knowledge of the risk of delay.

8th. The highest ascending grade on the railroad, from west to east from Cumberland to dam No. 6, is $26\frac{4}{10}$ feet per mile.

9th. In the recent answer to the house of delegates, it is stated, that upon a railroad from the mines to Cumberland, worked in connection with the road from Cumberland to dam No. 6, and with the same machinery, it will cost two cents per ton per mile on the former, and $1\frac{1}{2}$ cent per ton per mile on the latter; because the road from the mines to Cumberland is but ten miles in length, and dependant for its revenue entirely upon the coal trade. On this account its general expenses would have to be borne entirely by that trade, inasmuch as it would derive no such aid as it yielded to the Baltimore and Ohio railroad from the travel, and transportation of burden, by which this road is now supported. It is, therefore, obvious that the charges cannot be the same on both roads, although worked by the same machinery, as it is supposed in the recent answer.

Of the two cents per ton per mile, the assumed cost on the road from the mines to Cumberland, $1\frac{783}{1000}$ cent would be received by the Baltimore and Ohio railroad for transportation, and the remaining $\frac{217}{1000}$ cent would belong to the proprietors of the former road; and if the road be supposed to cost $150,000, and the expenses of repairs and management to be at the rate of $600 per mile per annum, it would require a trade of 163,576 tons over its entire length, in each year to pay an interest of 6 per cent. per annum upon the cost of construction. It might indeed be questioned whether the proprietors of a railroad from the mines to Cumberland would, for some time to come, be justified in charging so low a rate of toll as two cents per ton per mile, assumed in the recent answer. I have the honor to be, sir,

Very respectfully, your obedient servant,

LOUIS MCLANE, *President.*

[B.]

Estimates of the cost of transporting coal from Cumberland and from the Frostburg mines to dam No. 6, on the Chesapeake and Ohio canal—extracted from report of the undersigned, bearing date 31st Jan., 1844.

1st. As to the cost of transporting coal from Cumberland to dam No. 6, by the Baltimore and Ohio railroad, distance 45 miles. This estimate contemplates the employment of loco-

motives weighing 20 tons, and of sufficient power to transport 30 cars carrying 7 tons each, or 210 tons of coal per train, and that three locomotives will be required to perform the work of two, and that the season of canal navigation will continue 250 days—cars loaded in one direction only.

ESTIMATED COST PER DAY OF TRAIN CARRYING 210 TONS COAL.

Interest on 1 1-2 times cost of locomotive and tender per working day, (the cost of engine and tender being estimated at $10,000,) -	$3 60
Repairs and renewals of engine and tender at 9 cents per mile run with trains—90 miles per day, - - - - - - -	8 10
Oil for engine and tender, 1 1-2 gallons, at 90 cents. - - -	1 35
Fuel, 3 tons of coal at $1 68 per ton, - - - - - -	5 04
Wages of engineman and fireman, - - - - - -	3 50
Wages for two breakmen, one at $1 25, and one at $1, - -	2 25
Interest per working day on 75 coal cars, at $3 80 each, - -	6 84
Repairs and renewals of cars at a 1-4 of a cent per ton per mile—of load hauled, - - - - - - - - -	23 62
Grease for cars. - - - - - - - - -	1 50
Making a total of - - - - - - -	$55 80
Being at a rate per ton per mile of - - - - -	0·591 cents.
Add to this for wear and tear of road, bridges, etc., - - - -	0·250 "
And for contingencies, - - - - - - -	0·100 "
The total cost per ton per mile will then be - - - -	0·941 cents.

Two such trains as that above estimated (with less than which the trade could not be so economically conducted) would carry 105,000 tons of coal from Cumberland to dam No. 6 during the 250 days of canal navigation, which at two cents per ton per mile would yield a nett revenue of $50,037 75 at 1 1-2 cents per ton per mile, $26,412 75.

The amount of capital requisite to procure the machinery for two such trains would be $87,000.

21. As to the cost of transporting coal from the mines in the vicinity of Frostburg to dam No. 6, say 55 miles, engines, load, etc., as before—engines working two days and laying by the third for examination—average day's work of engines and attendants of train 73 miles.

ESTIMATED COST OF TRAIN PER ROUND TRIP OF 110 MILES.

Interest on 1 1-2 times cost of engine and tender per round trip, (cost of engine and tender as before,) - - - - - - - -	$5 40
Repairs and renewals of engine and tender at 9 cents per mile run, with trains,	9 90
Fuel, 4 tons coal at $1 per ton, - - - - - - -	4 00
Oil for engine and tender 1 3-4 gallons, at 90 cents per round trip, - -	1 57
Wages of engine and fireman, per round trip, - - - -	5 26
Wages of two breakesmen, one at $1 25, and one at $1 per day, per round trip,	3 37
Interest on 75 cars at $ 380 each, per round trip, - - - - -	6 84
Repairs and renewals of cars at 1-4 of a cent per ton per mile, of load hauled,	28 87
Grease for cars, - - - - - - - - -	1 87
Total cost of train per round trip, - - - - - -	$67 07
Being at the rate of - - - - - - - 0·581 cents per ton per mile.	
Add to this for wear and tear of road, bridges, etc., - 0·250 " "	
And for contenginciеs, - - - - - - 0·100 " "	
And we have as total cost, - - - - 0·931 " "	

Amount of money required to procure the machinery to run two trains per day under the above system would be 102,000 dollars.

The quantity of coal transported would be the same as in the former case—105,000 tons.

Nett earnings at 1 1-3 cents per ton per mile would be - - -	$23,215
" " 1 1-2 cents " " " - - - -	32,869
" " 1 3-4 cents " " " - - - -	47,937
" " 2 cents " " " - - - -	61,734

The cost of transporting a ton of coal from Cumberland to Georgetown, by railroad to dam No. 6, and thence by canal, will be as follows, viz:

First.—Supposing tolls and charges upon the railroad to be 1 1-3 cents per ton per mile, on 45 miles would be - - - - - - -	$0 60
And supposing charges for tolls and transportation on canal to be the same as assumed by the president and directors of the canal company in their report of the 16th November last, viz: 1 254-1000 cents per ton per mile, on 136 would be	1 70 1-2
Total cost of transportation, - - - - - - -	$2 30 1-2
Second.—Should the charge upon the railroad be fixed at 1 1-2 cents per ton per mile, add to the above - - - - - - - -	07 1-2
Total cost will then be - - - - - - - -	2 38

Third.—Should the charge upon the railroad be fixed at 1 3-4 cents per ton per mile, add the further sum of - - - - - - - -	11 1-4
Total cost will then be - - - - - - - -	2 49 1-4
Fourth.—Should the charge upon the railroad be fixed at 2 cents per ton per mile add as before - - - - - - - - - -	11 1-4
Total cost from Cumberland to Georgetown will then be - -	2 60 1-2
Fifth.—Should the road be extended to the mines, add for transportation and charges from the mines to Cumberland—say - - - - -	20
Making the entire cost from the mines to Georgetown, - -	2 80 1-2
The cost of conveying a ton of coal from Cumberland to Georgetown by the canal alone, at the rate above assumed, distance 184 1-2 miles, would be	2 31
Add to this the cost upon railroad from the mines to Cumberland, which upon a road so short as 10 miles, with no other support than that derived from the coal trade, and to be worked independently of the Baltimore and Ohio railroad cannot be much, if any, less than - - - - - - - -	30
And we have as the cost to Georgetown, by railroad to Cumberland, and thence by canal, - - - - - - - - -	$2 61

Respectfully submitted by JAMES MURRAY,
Engineer of machinery and repairs, Baltimore and Ohio railroad.

Baltimore, February 13, 1844.

I have carefully examined the preceding estimates and have confidence in their sufficiency for the purposes intended. BENJ. H. LATROBE, Chief Engineer.

ANNUAL RETURN OF THE MASSACHUSETTS RAILROADS FOR 1843.

In presenting an abstract of the Massachusetts railroad reports for the past year, we have to regret that the information to be derived from the accumulated experience of years is much less than might have been expected—owing to the absence of much of the detail necessary to a correct understanding of railroad statistics. There is, however, one exception, which particularly deserves notice and commendation—we refer to the Western railroad company, which, following the plan of the last report, has given us again a full statement of all its expenditures, classed under various heads, and affording at a glance the cost of any one department of the business.

Before laying before or readers the usual tabular statement, we shall offer an analysis of each of the reports, with such remarks as may be suggested.

Western Railroad.—From this very voluminous report we notice briefly such matters as may interest the general reader. The receipts for 1843 exceed those of the previous year by $61,194 23—a favorable indication of the prospects of this great work, as yet but barely entered upon its regular business. It is well known that the adoption of comparatively high or low fares has during the greater part of the last year, seriously occupied the attention of this corporation. From the report it appears that the determination of this question, as far as regards freight, was easily made—but that with regard to passengers a greater difference of opinion prevailed—owing to a want of co-operation on the part of the Boston and Worcester railroad company, the reduction of fare proposed was not as fairly tested as had been intended. The results are, however, strikingly in favor of the reduced rates. From the 12th of April to the 1st of December the fare for first class through passengers was reduced to two cents, and for first class way passengers to two and a-half cents per mile. The fare for second class passengers appears to have been about two-thirds of this. The reduction of fare has added most to the number of through passengers, and of these the increase is propor-

tionally greater for the second class, the number of which is more than doubled. The number of first class way passengers is but slightly increased while that of the second class has gained much more.

The whole *nett* tonnage of the road has increased a little more than fifty per cent., while the through tonnage has more than doubled. That this increase of business has not been unprofitable, we may judge from the fact that the number of miles run by all the engines has increased but about 11 per cent.—10 per cent. being the increase for the freight trains.

The report gives in detail the measures which have been taken to diminish the expenses of the company—these are chiefly directed to the reduction of salaries, and in some cases of the number of officers in the service of the company.

In comparing the expenses of 1843 with those of the previous year, several items are to be noticed as not included in former years, and, therefore, apparently adding to the expenditure of 1843—among these we notice $6000 as a settlement for the *collision damages* of 1841. A reference is made to the connection with other railroads—of these it would seem that the Boston and Worcester railroad company receive most profit from the Western railroad, the share of that company from the joint business for 1843 being $153,090. The arrangements at present existing are thought to be onerous to the Western railroad company, and are about to be revised.

The number of engines and cars has been augmented to meet the increased business of the road. Five locomotive engines have been added to the stock and three more are ordered.

The wood sheds are now sufficient for the protection of *upwards of 20,000 cords of wood.* The expenditure for this purpose, and for the supply of water for the protection of the bridge over the Connecticut and other property from fire, are made in the proper spirit, and come under the good old rule as the "ounce of prevention."

Another item of expense of a novel character is deserving of notice—the erection of 5000 feet of fence to protect the road bed from snow drifts—the result is stated to be "highly satisfactory," and this mode of protection will probably be extended. When we find under the head of *snow* the sum of $11,867 45 expense for 1843, we can easily imagine the necessity of some defence against the attacks of this enemy.

The arrangements of the depot at Greenbush are completed upon a magnificent scale. By means of steam power, goods are transshipped with a difference of level of over 20 feet between the cars and canal boats. The unfavorable nature of the site has added to the expense of this and other necessary arrangements at the depot.

The Albany and West Stockbridge railroad has been completed at the cost of $1,756,342 78.

In fine, we cannot but think that this most important work is destined to

become as profitable to its stockholders as it is already beneficial to the public. It is true there are serious difficulties to contend with—a mountain region with severe grades, subject to obstruction from snow in winter, costly depots, and heavy expenditures at various points. These are, however, fully counterballanced by the value of the route and the constant growth of local as well as through traffic. The results, too, which have been attained, are for the first two years, everything being comparatively new and untried. No doubt a judicious economy and suitable regulations as to fare, together with an equitable arrangement with various connecting roads, will lead to a prosperous condition.

Berkshire Railroad.—This company has arranged matters so that the capital, $250,000, shall exactly meet the cost of the road, depots, etc. It is now loaned for 7 per cent. to the Housatonic railroad company, and no statistics can consequently be furnished by the owners of the road. The small incidental expenses are met by a fund appropriated to that purpose.

Boston and Lowell Railroad.—This company in the full tide of prosperity has given a very short and rather meagre report—at least as far as statistics are concerned. More than two-thirds of its revenue is derived from traffic, in connection with the Boston and Maine, Nashua and Lowell and Concord railroads.

A dividend of 8 per cent. has been paid out of the profits of the last year. The sale of the old iron has been completed, and the entire cost of the new having been formerly charged to repairs, the difference, together with ballance of interest account, is taken from the cost of the road—which now stands at $1,863,746 16. All calculations of annual expenses, based upon the previous reports of this company, will therefore need a large discount; it is hardly necessary to say that all estimates as to the wear and tear of railroad iron will need a like alteration.

Boston and Maine Railroad.—Since the last report, this road has been so far completed as to be in use throughout its whole length; the following statistics will, therefore, be of interest:

Amount expended in construction of road in Massachusetts,	$431,592 15	
do. do. New Hampshire,	723,058 11	
Total,		$1,154,650 26
Amount expended in engines and cars,		98,886 73
do. depot and other buildings in Mass.,	21,146 78	
do. do. New Hampshire,	17,666 43	
Total,		38,813 21
do. do. other miscellaneous expenses in Massachusetts,	45,914 85	
do. do. New Hampshire,	45,734 67	
Total,		91,699 52
Total amount,		$1,384,049 72

Length of road in Massachusetts,	20·354	miles
do. New Hampshire,	34·954	"
do. Great Falls branch,	2·936	"
Total,	58·244	"
Length of road in side tracks,	3·092	"

Number of planes, 130—of which 32 are level, 57 ascend and 40 descend from Wilmington. By a singular mistake, the report makes these grades 1000 feet per mile, we presume that ten feet is intended.

The greatest curvature is 1050 feet radius; the average width of grade 14 feet.

"The manner in which the superstructure is laid is as follows:

"The earth excavations and embankments are levelled off and one and a half feet of sand, or gravel, is then filled on to the road; the subsills of plank are then laid longitudinally, and the sleepers of chesnut, cedar or hackmetac are laid transversely, partly two and one half feet, and partly three feet apart. Iron rails of the T pattern are then laid, supported at the joints by cast iron chairs, and spiked to the sleepers; sand or gravel is then filled in between the sleepers.

"The Maine, New Hampshire and Massachusetts railroad is an extension of the Boston and Maine railroad, through Berwick so as to intersect the Portland, Saco and Portsmouth railroad at South Berwick, in Maine, and the Boston and Maine railroad have contracted to pay the stockholders of the Maine, New Hampshire and Massachusetts railroad company the same dividends per share as is paid to their own stockholders. By virtue of this agreement there has been received by the Boston and Maine railroad the funds of the Maine, New Hampshire and Massachusetts railroad company, not required to construct their road, and their surplus funds will, upon the union of the two corporations, be applied to the payment of the debt of the Boston and Maine railroad."

The above named roads have likewise entered into a contract for the mutual advantage and co-operation of their respective lines.

Although this road has not been completed throughout, and in operation for the whole year, a dividend of 6 per cent. has been declared on last year's profits.

Boston and Providence Railroad.—During the past year 18,598 new sleepers have been laid, about 13,000 will be required this year—the road is said to be now in better order than for several years past.

The earnings on the Dedham branch are said to be "very satisfactory," and fully to compensate for running a locomotive engine for the accommodation of the inhabitants of Dedham.

An arrangement has been made with the lines from New York, by way of Stonington and by way of Norwich, by which the rates of fare for freight and passengers for both the lines are the same, and the receipt equalized, except that the line transporting an excess receives a reasonable compensation therefor.

The amount charged to the account of construction has been increased this year by about $2000, but will shortly be diminished by the sale of property worth over $15,000. A dividend of 6 per cent. has been paid for the past year.

Boston and Worcester Railroad.—Since the last report the second track has been laid upon this road, and to meet this and other expenses, 2000 shares have been created and taken up proportionally by the stockholders. The capital is now $2,900,000.

The second track is laid with a heavier rail than the first, and in a more substantial manner, being therefore better adapted to the present heavy traffic of the road.

Two trains run daily, in connection with the Western railroad, to and from Albany, and one train daily connects with the Norwich and Worcester railroad, forming a daily communication to and from New York. A permanent arrangement has been made with the Norwich and Worcester railroad company, by which the joint transportation of passengers and merchandize over both roads is regulated on terms said to be "mutually advantageous and satisfactory, and also advantageous to the public."

Beside the regular through trains, three trains run daily in each direction between Boston and West Newton, affording accommodation to the vicinity of the city, and relieving the regular trains of their heavy loads at this end of the line. By these arrangements it will be seen that forming important connections, this is preparing to meet the vast trade to which it is destined and which, in a great measure, it already receives.

(To be continued.)

For the American Railroad Journal and Mechanics' Magazine.

ON THE CAUSES OF THE GENERAL FAILURE OF CANALS IN AMERICA.—BY W. R. CASEY, CIVIL ENGINEER.

It is obvious that some inherent defect must exist in American canals generally to have brought about the present deplorable results. It is true that nearly all these works have been constructed by the governments of the different States and Provinces and under all the well known disadvantages of that system; and, we might argue with some reason, that in the hands of private companies they would have been more efficiently as well as more cheaply completed, owing to the superior sagacity, integrity and skill of the directors and engineers of works carried on by private enterprize. Thus it is no uncommon thing to see a president, board of directors and engineer at the head of a small private work, costing two or three hundred thousand dollars, in every respect—character, skill and wealth—incomparably above the government commissioners, boards of works and their engineers, entrusted with the disposal of millions. But admitting all this, it would merely show that the cost of the works had been too great, while in practice we find, that besides this obvious disadvantage, they labor under the still greater one of having—practically speaking—no income, as in the case of the Chenango canal, which has a gross income of about $13,000, on a cost of 2½ millions. The following extract from this *Journal* for 1839, p. 363, gives the true solution:

"In some States, the grand argument will be, that if they can only complete the works commenced, a revenue is immediately certain, which will render taxation to pay the interest unnecessary. That the completion of these projects will make the fortunes of many individuals, is well known, but, for the permanent interests of the State, the only plan is, to sell out at once with the present comparatively trifling loss. It is impossible to pay too much attention to the fact, that the greater part of the works projected by the governments of the different States are not such as will ever be of any essential benefit, and when we add to this that they are constructed at twice the cost of similar works in the hands of companies, are generally much inferior in execution and always managed and repaired in the

most inefficient manner—we shall be at no loss to account for the present condition of State works in general." (See also Civil Engineers' Journal, vol. iii, p. 124—London.)

The only canals which now yield a surplus are the Erie and Ohio canals, owned by the States of New York and Ohio, and the Delaware and Hudson and Schuylkill canals, owned by private companies in New York and Pennsylania.* The Larkine canal in Canada was productive, but being now in the hands of a "board of works," is not likely to remain so much longer. Its "enlargement" has been already commenced. Volumes would not convey to the citizens of New York all which that single word conjures up.

Had the Erie and Ohio canals been left to their own resources their stock would never have been at par. The former received six millions from tolls during the first four years of its existence—nearly its entire cost—and the comptroller shows, doc. 40, p. 45, 1844, that, charging and allowing interest, the balance is $4,179,291 46 against the canal—omitting, of course, the enormous sums spent on the enlargement. The canals of Ohio have been, and continue to be supported by direct taxation, and that alternative has become necessary here for a few years at least. The two private canals above alluded to lead to the anthracite region of Pennsylvania; one, the Schuylkill canal, *has* made immense dividends, but the stock has fallen greatly, and the toll has been reduced to three mills per ton per mile! the other is successful.

The Erie canal, though conferring considerable benefits on the country, has also exerted a powerful influence in a contrary direction, and for five months of each of the last four years it has been complained of—each succeeding year more bitterly—as an intolerable nuisance, injuring alike the western producer and eastern consumer by its hideous monopoly. Canals intended for the coal trade are comparatively little affected by the long winters of New York and northern Pennsylvania; but, canals drawing their main income from the country through which they pass, and, still more so, those depending on the trade of the lakes, have their usefulness greatly im-impaired by being closed during the winter months. This objection is insuperable, becomes stronger every year, and will, in my opinion, prevent the undertaking of any more canals in the couniry, north of Philadelphia at least.

Again, the grasping spirit in which many canals have been projected has been ruinous to their prospects for any reasonable period. The enlarged Erie and the Brobdignag canals of Canada were each to bear to the ocean *the* trade of the west; the Lehigh and Schuylkill canals were each to furnish the avenue for *the* coal trade of the country. But we find the coal as well as the western trade flowing through numerous channels already, and many more will soon be added. In England, canals are generally successful, but though doing an immense business they are very small, some of the most important having locks only eight or ten feet wide. Again, the capital

* The canal round the falls of the Ohio is of course omitted.

invested in all the private canals in the kingdom is only £5,775,000 sterling, about the sum expended on canals in New York, little more than the cost of the canals of Pennsylvania, and about twice the probable cost of the canals of Canada. What a contrast between the views of those investing their own money, and the conduct of those who expend the money of the public! Eighteen millions of people, with wealth, industry and enterprize unparalled in the annals of mankind, expend in fifty or sixty years about thirty-four millions of dollars: six millions in Pennsylvania, New York and Canada, with wealth comparatively nominal, contrive to lay out about sixty millions of dollars in one fourth the time. The capacity of these little English canals is immense, their cost and management comparatively slight and easy.

A boat will carry about 30 tons, and as one of the old single locks of the Erie canal passes 116 boats in 15 hours, a lock little more than half the width will easily pass 200 boats per 24 hours, and is abundantly adequate to the trade of any canal likely to exist in this country. The English canals, with a small amount invested in their construction, accommodate an immense traffic, and are as valuable to their proprietors as they are useful and honorable to the country. Here the reverse is generally the case. For example, the Genesee valley canal will cost about $60,000 per mile, the cost of the Lowell railway, the best in America; the income of the former is estimated by its friends at one-half of one per cent. per annum, the actual income of the latter is 15 per cent. Again, one mile of the Cornwall canal in Canada cost as much as fifteen miles of the Champlain and St. Lawrence railway, with cars, engines, buildings and wharves, and it will be fortunate if the income from the twelve miles of canal equal half the revenue of the railway. The two private railways are adapted to the business of their respective localities; viewed in this light, the two government canals are monstrosities of the first order.

The Ohio canal is well worthy of the most serious attention. This work is above 300 miles long, is without a rival, cost only $4,000,000, traverses the heart of a superb country containing two millions of inhabitants, and connects the two greatest chains of inland navigation on the face of the globe —the Ohio with the lakes. Yet the gross income last year was only $322,-754 82, yielding, according to the commissioners, "4½ per cent on the cost of the canal." Had not this canal been constructed at the moderate cost of $13,000 per mile, it must have been supported by taxation, as is now the case with the other canals of that State, for some of which money has been borrowed within a few years at 7 per cent.! though their sources of income are far inferior to those of the Ohio canal, which, in fact, ranks next to the Erie canal. Ten years' experience on this canal demonstrate, in a manner admitting of no cavil, that the wealthy and—for America—populous region of Ohio barely supports one of the cheapest, if not the very cheapest canal in the country. The Erie canal has been a complete "ignis fatuus" to the other States, having been paraded before the country as a work which had cleared its prime cost, when in fact it was in arrears for interest. The singu-

lar advantages of the position of the Erie canal, its heavy grants and peculiar privileges render it a dangerous, a ruinous precedent. The following extract from Hunt's Merchants' Magazine for August, 1843, gives a general view of the causes which prevent the success of canals in this country:

"Well projected railways claim the favorable attention of the merchant, because they offer safe and profitable investments, besides aiding commerce generally by their unrivalled facilities. They are peculiarly adapted to this country, where the population and business are so scattered, and where capital is not abundant. Unlike canals, the cost of a railway may be adapted to the trade. In most parts of the country a railway can be put into operation for about $20,000 per mile, including engines, cars, buildings, etc., for a single track —less than half the average cost of the Chenango, Black river and Genesee valley canals, without boats, buildings, horses, etc. Again, a railway carries passengers as well as freight, and both throughout the year; so that, with less than half the cost of the canal, its receipts are several times greater. It is on this account that canals must be costructed as cheaply as possible, to have any chance of success here. Even in a mineral region—the most favorable of all—their being useless half the year is an insuperable objection; and this again becomes intolerable when advancing civilization renders a communication, open throughout the year, indispensable to the community. It appears, therefore, that three vital obstacles to the success of canals exist: their enormous cost, compared with railways, their small income, their being closed nearly half the year in this wintry region. The two last objections are insuperable, and will as effectually deter individuals from embarking their own means in canals as would the first. With politicians, spending the money of the public, the case is reversed. They uniformly prefer those works which require the largest expenditure and the longest time to execute, these two conditions furnish the best "opportunities." The $20,000,000 spent in this State, on works which can never be required, afford only too true an illustration; but the course of the Canadian government, for the last two years, distances the wildest visions of the wildest western States, even during the phrenzy of '36.*

"The railways diverging from Boston in all directions, which have been projected, executed and managed by companies, form the only successful system of public works on this Continent, and would command a large advance on their total cost."

The railways of the United States were undertaken, principally by individuals, after the canals, and though nearly one hundred millions of dollars have been invested in them, they yield about five per cent. The railways of England—the most extraordinary works the world has yet seen, and exclusively the results of private enterprize—have been constructed within fifteen years, at the enormous cost of £52,000,000, and yield a fair return on the capital. It is obvious, therefore, that their sources of income differ materially from those of canals—in other words, that, though both may succeed, a railway may flourish where a canal cannot exist. For example, the Middlesex canal has been abandoned, and its place supplied by the Lowell railway.

The trade of the canal between Liverpool and Manchester has increased since the opening of the railway between those points. When the population and trade of this country shall approach those of England, it is not impossible that canals of reasonable dimensions, cheaply constructed, may succeed in some of the more southern States.

* To prevent erroneous conclusions, it may be well to state that the resources of a British Province differ materially from those of a State. The former has the duties Imperial as well as Colonial, and contributes nothing to the support of army and navy; it has also the public lands. Hence Canada, as a Colony, bears an expenditure, which, as a State, would be entirely beyond her ability. For several years no statements have been published from which the true state of the finances of the Province, and consequently of the public works, could be gleaned. But the remarkable man now at the head of the government will unquestionably force from the Board of works something definite and tangible, and, I will venture to predict, that a clear straightforward statement of the sums actually expended, the probable—not estimated—amount required to complete the works as well as their present and probable future income, will literally "astonish the natives," who will at once wake up from their puerile discussions of colonial abstractions to the thorough conviction that the utmost efforts of their able governor, as well as of themselves, will be required to counteract, even in a small degree, the withering influences of a debt contracted for the most visionary purposes—a term, I fear, far too mild. There is, of course, little probability that the works commenced will ever be completed.

The public are just beginning to appreciate the losses sustained by the five months' annual sleep of the canals, and the papers from Boston to Detroit have, during the past winter, teemed with invectives against the law of New York which actually denies to the farmer that which the State of Maryland accords to the slave—the right to send his produce to market in any way he pleases—by turnpike, railroad or steamboat. But not only do the canals furnish a tedious route during a little more than half the year, but that very circumstance tends to raise the cost of that inferior accommodation, for the cost of maintaining them would be nearly the same were they open throughout the year, and the income would be greater; the same capital and annual expenditure would yield double the income.

The advantages of the Erie canal in a military point of view have been painfully dwelt on. Yet it can never be more than a very humble auxiliary of the private railways from Albany to Buffalo during the summer months, its opening being too late and its closing too early to render it of any value at the most important moments—the commencing and closing of a campaign. More than this, these very works have been built in spite of the canal interest which is still an incubus on the spirit of honest enterprize. Again, the Rideau canal is a truly military work, yet a railway from Montreal to Kingston, at a cost of four millions of dollars, would, in the event of war, save more than this sum annually, and would render that portion of the province impregnable to any force likely to be brought against it. It would also clear expenses, and three or four per cent. even now. So with regard to Buffalo, a force overwhelming from its numbers could be collected there in a few days. During the late insurrections in Canada the £40,000 sterling, invested by a few individuals in the Champlain and St. Lawrence railway, contributed materially to the defence of the province, while the millions spent on the Imperial and Colonial canals were absolutely useless. In case of a protracted contest the canals would of course come into play to some extent.

The main "causes of the general failure of the canals" of this country may be ascribed to their being closed nearly half the year; to the small amount of business their peculiar accommodation enables them to command in a thinly settled country; to their low rate of speed, and to their—with few exceptions—great cost. Whether these objections are likely to be overcome to any extent worthy of notice, the reader must decide for himself. For my own part, I doubt whether the canals, from the St. Lawrence to the Mississippi will, ten years hence, have yielded one per cent. on the capital invested in their construction; and, omitting the Erie, Ohio and the two private canals referred to above, I do not believe the others will, during that time, clear repairs and renewals: in other words, that their failure will be complete and will in some cases lead to their abandonment.

Since the above was written, I have seen the report of the canal committee to the senate, doc. 98, 1844, which, with that devotion to principle, so prominent a trait in the American politician, according to de Tocqueville, is

very severe on those projects which have become decidedly unpopular—the lateral canals and the enlargement—but says not a word of a vastly greater evil, the canal monopoly. The arguments against any further expenditures are part of those used by others, myself among the rest, some years since, when twenty of the present debt of twenty-eight millions might have been saved. There is, however, a good illustration on page 15, where, speaking of the Chenango canal, it is said—"Thus it is seen, it would have been cheaper for the State to have made a road and hired teamsters at expensive rates to transport the produce of that country in ordinary wagons; and the community would have had the free use of the road for common purposes."

I made a similar calculation some years since. The expenses and interest on the cost of the Cornwall canal, twelve miles long, will be $8,000 per mile, and we will assume that it will clear $1,000 per mile per annum besides paying repairs and renewals—of which there is little probability. Then two years' interest or $16,000 per mile, will build and equip a good railway, and three months' interest, or $2,000 per mile will clear *all* the expenses of several times the total down as well as up-freight of the St. Lawrence, and of ten times the present number of passengers. In other words, the entire trade and travel in both directions would be free, and the province would save $5,000 per mile per annum, or $60,000 on twelve miles of canal. The interest on the actual cost of the Cornwall canal, and on the estimated cost of the short canals round the rapids above, would pay all the expenses of a continuous railway carrying more freight and passengers than will probably be found on that route twenty years hence: that is, the mere interest on the cost of the canals would pay for free travel and transportation on a railway.

"Now it is obvious, that such men as Brunel, Stephenson, Walker, and a host of others in England, and we are proud to say, not a few in this country, whom we do not feel ourselves at liberty to name, are found utterly impracticable in such cases, and they are consequently avoided with as much care by the projectors of works to be built on the credit of the government, as they are zealously sought for by those who project works to be executed by the expenditure of their own actual capital. The evil of employing men incompetent from want of education, practice and character eventually recoils on the State; hence the financial difficulties of all the States who have largely embarked in the construction of public works." (Railroad Journal, 1839, p. 354. C. E. & A. Journal, vol. iii, p. 122—London.)

New York, May, 1844.

"Two schooners arrived at Oswego on the 9th, from Toledo, via the Welland canal, with 11,000 bushels of wheat, to Carrington and Pardee, millers there, who, we dare say, will have it made into flour, and ready for this market before the canals are open." (N. Y. Journal of Commerce.)

Many of our readers will remember an article on the "Spring Trade," written by Mr. Casey for this Journal, April, 1842, in which he shows the great superiority of the route *via* the Welland canal for early freight; and here we have cargoes *landed* at Oswego long before the *opening* of the Erie canal at Buffalo. The Welland canal was opened on the 2nd April, and merchandize from New York and Boston would have been "afloat on lake Erie," and "if the people were allowed to choose the mode of transpor-

tation according to their own ideas of their own interest."—*Journal, April,* 1842, *p.* 246—goods would have been landed at Detroit and Chicago a month earlier than they will be *via* the Erie canal.

In his article on the "Canals of Canada,"—*Journal, Nov.*, 1842, *p.* 158—Mr. Casey expresses his belief that the Welland canal "will eventually cease to be a burden on the province." Without offering any opinion as to the time when this is to take place, which Mr. Casey considers tolerably distant—very safely, too, according to our views—we propose, after his example, and that of the canal commissioners, to make a calculation also. This canal is *estimated* at above $100,000 per mile, and is about 40 miles long. Total cost $4,000,000! One million of dollars will construct and furnish a first rate single track, and the interest of the remaining three millions will pay all the cost of carrying 300,000 tons of down freight, and 100,000 tons of up freight. We do not know the tonnage of that canal, but think it will scarcely exceed our estimate for some time to come. However useful this work may be to New York and some of the western States, we see little probability of its becoming what Mr. C. calls a "successful work," a term which ought to be applied to no work which does not yield a fair revenue to its *proprietors*, as well as contribute to the accommodation of the public.

COST OF TRANSPORTATION ON RAILROADS.

The statement marked C, accompanying the "reply," of the Baltimore and Ohio railroad company was intentionally omitted; it being only designed to show how the increase in the coal trade may be provided for out of the profits arising from that branch of business; but the following estimate of the cost of transporting coal from the mines to Baltimore, a distance of 188 miles should have been given in its proper place following estimate B. It will not, however, we trust, be overlooked by our readers, even thus detached, as it gives a concise, yet clear statement of the cost at which heavy freights may be transported over railroads, with grades even greater than were, a few years ago, deemed passable by locomotive power.

These replies ought to be extensively circulated by the friends of railroads; and more especially in *this* city, at *this time*, when an appeal—*not the last*, however, *even if unsuccessful*—is about to be made in behalf of the New York and Erie Railroad—a work from the completion of which every *property* holder—every *business* man—every *carman* and every *day laborer* has a *direct* and *deep* pecuniary interest; and, therefore, it is important that they should be able to appreciate the capacity, the facilities and the economy of railroads, when judiciously located between important points. And can a more favorable or judicious location be found than between the city of New York, on the one hand, and lake Erie, on the other? or between the Atlantic ocean and the far and boundless west?

We have not a doubt but that the means to complete this road could be readily obtained in this city alone, and without delay, if our enterprizing Boston friends would favor us with the *loan* of their noble "Western railroad" for a few weeks, that our cautious citizens could see and *feel* its ope-

rations and its influences—or, indeed, if the *facts*, contained in this one number of the Journal alone, could be *generally* read and *duly appreciated* by all, the entire amount required would be forthcoming, and the work would be completed in less than three years—as we confidently predict that it will be in less than *five*.

[D]

Estimated cost of transporting coal from the mines in the vicinity of Frostburg to Baltimore, distance 188 miles—supposing the use of locomotive engines of 20 tons weight, and of sufficient power to carry 25 cars containing 7 tons each, or 175 tons to the train—three locomotives being required to do the work of two, 300 working days during the year, and that equivalent to four days will be required to make the round trip.

Interest on 6 locomotives and tenders at $10,000 each per round trip of 4 days,	$12 00
Repairs and renewals of locomotives and tenders at 9 cents per mile, run 376 miles per round trip, - - - - - - - - - -	33 84
Fuel per round trip, 15 tons at $2 per ton, averaged Harper's Ferry, -	30 00
Oil for engine and tender per round trip, 6 gallons at 90 cents per gallon, -	5 40
Wages of enginemen and firemen, - - - - - - - -	14 00
Wages of breakmen, - - - - - - - - -	9 00
Interest per round trip on 200 cars at $380 each, - - - -	15 [illegible]
Repairs and renewals of cars at 1-4 of a cent per ton per mile of load hauled, (32,900 tons per mile,) - - - - - - - -	82 25
Grease for cars, - - - - - - - - - - -	6 00
Add for use of auxiliary engine at Parr's Ridge, - - - -	12 00
And we have as the total amount of the round trip, - - - -	$220 [illegible]
Being at the rate per ton per mile of - - - - - - -	0·670 cts.
To which add for wear and tear of railway at 1-4 of a cent per ton per mile west of Harper's Ferry, and 45-100 of a cent per ton per mile east of Harper's Ferry, averaging on the whole distance, - - - -	0·337 "
And for contingencies, - - - - - - - - -	0·100 "
Making the total cost per ton per mile, - - - - - - -	1·107 "
At 1 1-2 cent per ton per mile, and 10 cents extra charge for transportation through the streets of Baltimore, the charge for conveying a ton of coal from the mines to the city block in Baltimore would be - -	$2 92
And the annual nett revenue of the company on the amount of trade assumed in this estimate - - - - - - - - -	$38,789 10
At 1 1-3 cent per ton per mile and 10 cents extra, as in the former case for conveyance through the streets of Baltimore, the charge for transporting a ton of coal from the mines near Frostburg to the city block in Baltimore, would be - - - - - - - - - - -	2 61
And the annual nett revenue of the company on the same amount of trade,	$22,306 [illegible]
The amount of investment in machinery to accommodate the trade above assumed would be, - - - - - - - - - -	$136,000 00

Respectfully submitted,
JAMES MURRAY, Engineer of machinery and repairs.

February 13th, 1844.

I have carefully examined the preceding estimates and have confidence in their sufficiency for the purposes intended BENJ. H. LATROBE, Chief Engineer.

NEW YORK AND ERIE RAILROAD.

The time has arrived for *every man*, who desires the completion of this great work, to put his shoulder to the wheel, or take a pick axe and shovel and go to work in earnest. Annexed will be found the candid, manly, and earnest appeal of the company to the *citizens* of New York individually, for aid in its completion. In giving place to this appeal, we cannot withhold the expression of our surprise that a work of such vast importance to this city should be looked upon with so much apathy and distrust by its citizens; and its friends be compelled to solicit, and urge those who are to be

so largely and so *permanently* benefited by its completion, to contribute the means for its construction; nor refrain from earnestly urging those who can possibly do so, to come forward and subscribe for stock, at least a few shares, if they cannot for many. Every owner of *real* estate—every *merchant*, *manufacturer*, *mechanic* and *carman*, and even many day laborers will promote their own permanent interest by *taking one* or more shares, and thus aid its early completion, even if he never receives a penny in the way of dividends. Its completion will benefit New York as much or more than the construction of the Erie canal did. Its influences will be more universal, as every poor family, using only a quart of milk daily, will save *two* cents at least each day—or $7 30 a year; and at the same time obtain a better article. And so with *butter*, and many other articles of *necessity* and comfort—the prices will be materially reduced in consequence of the increased facilities for bringing them to the city. The saving to the inhabitants of this city alone, upon the *necessaries of life* cannot be less, when the road shall be completed, than *half a million* of dollars a year. This, however, is but one item in the list of benefits which will surely result from its early construction. Others, equally important, will follow, in the increased value of property in the city, and along its line, to the amount certainly—by the time the *first car* shall pass from the Hudson to lake Erie—of *twice* the entire cost of the road. Is it not the duty, then, of those who are thus to be benefited, to respond promptly to the call of the company, by subscribing for such an amount of stock as they may be able to pay for, without interfering with other business arrangements? We think it is, and believing so, shall act accordingly, and charge the *Journal* with at least *one* share, and more if we can do so. *Let others go and do likewise.*

ADDRESS TO THE PUBLIC, OF THE NEW YORK AND ERIE RAILROAD COMPANY.

Office of the New York and Erie Railroad Co.
New York, 11th April, 1844.

The common council have declared by resolution that it is not expedient that the city of New York should subscribe to the capital stock of the New York and Erie railroad company, and having declined to unite in the application to the legislature, the directors are under the necessity of opening the books for private subscription without the important aid which the corporation of the city would have afforded.

With their convictions as to the importance of the road, the amount of capital required, and the principles on which alone the board were willing to undertake its completion, they could not consistently decline to bring forward the question of a city subscription. At the same time it was felt that the great responsibility involved in the decision of that question should not rest with them even indirectly, but belong either to the common council, the legislature, or the people.

By the course pursued, the question could not reach the people without the sanction of the common council, and the authority of the legislature. That sanction having been refused, the application to the legislature will not be made; and the completion of the New York and Erie railroad now depends entirely upon the amount that can be obtained by private subscription.

Before determining the conditions, on which books of subscription to the

capital stock are to be opened, the board have again had under consideration the position assumed in their report, that six millions of dollars are necessary before the work should be resumed.

After much deliberation, the board continued of the opinion that the conditions of the subscription should require that the amount to be subscribed before the resumption of the work, should be such as would place the completion of the road beyond ordinary contingencies; and they cannot satisfy themselves that a smaller sum than six millions will comply with this condition.

The board have not overlooked the important considerations which induce many to believe that a smaller sum in connection with the other resources of the company would be adequate; but those considerations, in their opinion, are not sufficient to remove all reasonable doubt; and no other basis would be consistent with the views of the board, the responsibilities of their position, and the principles on which they consented to undertake them.

In their anxiety to remove every circumstance which may have an unfavorable influence on new subscriptions, the board have been constrained to discriminate between old and new stock, and that this may be effected without permanent injury, if any, to the interests of old stockholders, it has been done in the manner stipulated in the conditions of subscription.

The priority of dividend thus to be secured to the new stock is made dependent on the action of individual holders of stock already issued, in consequence of the legal opinion that neither the board of directors nor the stockholders legally convened, possess the power to make any distinction between stocks issued at different periods.

In accordance with these views, the following are the conditions under which the subscription books are to be opened.

"We, the undersigned, respectively subscribe for the number of shares of the capital stock of the New York and Erie railroad company, of one hundred dollars each, set opposite our names, and hereby agree to pay ten dollars on each share within twenty days after the closing of the books, and the subsequent instalments as they shall be legally called for, provided,

1st. "That bona fide subscriptions subsequent to 1st of March, and prior to 1st of August, 1844, shall amount to the sum of six millions of dollars.

2d. "That the instalments shall not exceed thirty-three and one-third per cent. per annum.

3d. "That by the individual acts of at least three-fourths of the amount of stock issued prior to the 1st of March, 1844, it shall be legally established, that dividends when made shall be declared on the following basis:

1st. "That the right of dividends on at least seventy-five per cent. of the old stock shall be deferred until a dividend of six per cent. shall be declared on the new stock.

2d. "That when the nett earnings shall exceed the amount necessary to pay such dividend to the new stock the excess shall be appropriated to dividends on the old stock.

3d. "That when dividends so declared on old stock amount to six per cent. per annum, the old and new stock shall be put on a par, and all distinction between them shall thereafter cease."

The board have the satisfaction of believing that the great question of the completion of the New York and Erie railroad is now before the citizens of New York, and of the counties interested in its construction, freed of all extraneous considerations; that public attention has been fully drawn to the subject, and that there prevails throughout the community an appreciation of the importance of the road, and a confidence in its success when completed to lake Erie, that are of the most encouraging character.

The board will adopt all suitable measures to obtain the very general action on this subject, which the large amount to be raised renders necessary, and trust that their efforts will be efficiently seconded by all who unite with them in opinion that the completion of the New York and Erie railroad, while it affords every prospect of remunerating dividends to stockholders, will be of great and permanent benefit to the city and country.

HORATIO ALLEN, *President.*
JAMES BROWN, *Vice President.*

D. A. Cushman,	C. M. Leupp,	Harvey Weed,	F. W. Edmonds,
Silas Brown,	A. G. Phelps,	Theo. Dehon,	Matthew Morgan,
P. Spofford,	John C. Green,	Wm. Maxwell,	A. S. Diven,

Elijah Risley.

For the American Railroad Journal and Mechanics' Magazine.

SCHUYLKILL NAVIGATION.

Failure of Railways.—It is still maintained by a correspondent of the Journal, "X," that it is very impolitic to graduate the capacity of a railway or canal with any reference to the trade which it is intended to accommodate; or, as he characteristically describes the principle, to *measure* the probable tonnage, for the purpose of determining the capacity of the railroad which is to convey it, as you would individuals for their clothes—varying the size with the circumstances of the case. He proposes, as the true principle of tailoring, to put a man's suit on a boy, and a woman's dress on a baby; and calls up the Schuylkill navigation in illustration of the soundness of his views.

The example will be found to be very unfortunately selected, for the object at which this writer seems to be aiming.

The Schuylkill navigation was constructed between the years 1815 and 1825; and we believe has been prosecuted on those common sense principles which have been recommended by Mr. Ellet for the construction of railways. It was made at first on a small scale—because the trade was expected to be small at first—and with a view to its gradual enlargement—because the trade was expected to increase.

In 1826 the depth of water was but three feet, and barely adequate to the passage of boats of 25 tons burden. The purpose of its projectors was fully answered. The canal soon *created a trade*, and that trade increased sufficiently to justify the anticipated enlargement of the channel. From year to year the capacity of the work has been augmented, until it now permits the ready passage of boats of 60 tons burden, while occasionally more than 70 tons have been carried upon it.

The Schuylkill navigation company have expended in the construction and enlargement of this canal the sum of $3,456,620.

Their aggregate receipts from tolls on coal, and other articles, up to January 1st, 1844, have amounted to - -	$5,641,255
Their aggregate expenses have been - -	1,768,792
Leaving a nett profit of - - -	$3,872,463

or $415,843 more than the whole cost of the work and its enlargement.

Now, these results are pretty fair, and certainly do not, of themselves, authorize a condemnation of the present course which the managers of this work have adopted.

But the Reading railroad company, it is contended by "X," have adopted a different plan—that of making a very expensive road at the outset. Let us see how their method works.

The Reading railroad is now new, and, together with all its machinery, ought to be in perfect order. It was in full operation last year, and carried about 230,000 tons of freight, and some 26,000 passengers.

The company expended during the year, - -	$1,800,000
And received for freight and passengers, - - -	385,000
And exhibited, at the close of the year, an excess of expenses beyond their receipts of - - -	$1,415,000

Of this sum just $212,000 was expended for new cars and engines, and about $90,000 for new work on the road. The balance of about $1,100,000—of the sum by which the expenses exceed the receipts—appears to have been consumed in conveying these 230,000 tons of coal. At any rate, no other explanation of its disappearance has ever been offered.

Our friend "X" speaks with some severity of certain *slanders* against the Reading railroad, which, he says, have appeared in the Philadelphia newspapers; and charges us with wishing to give them greater circulation. We are sorry to learn that this company has been slandered by any body; and we do assure him that if they have suffered in that way, we have had no part in it, and have never before heard of the circumstance. It is true, we have read some very severe and scourging strictures on the conduct of the institution, in the columns of the "Pennsylvanian," "Ledger," and "North American"—but we always supposed that they were true. Certainly, nobody in Philadelphia doubts their truth, nor has any person yet ventured to come forward and attempt to disprove them.

But "X" is chivalric, and we shall look to him to tell us, specifically, what the Reading railroad company did with the $1,800,000 which they spent last year.

For ourselves, we wish not to injure this company, but we wish to make the truth known; and we supposed when we exhibited the strong comparison drawn by "X" himself, in the strongest possible light, we were doing good service to his hobby. This, it will be recollected, is his language.

"Still another comparison may be made between the Schuylkill canal which cost $38,000 per mile, without boats, and the Philadelphia and Pottsville railroad, which costs $50,000 per mile, with cars and motive power." "Is it not," says X, triumphantly, "*is it not this additional cost which makes it the superior and cheaper work of the two?*"

Now, I say, the great merit of this road was, in the opinion of "X," its great first cost; and I was justified in supposing that I was giving most gratifying information, when I informed him that it had, on the 18th December last, increased this merit to $76,000 per mile. What its merits will amount

to at the end of this year, it is not easy to say—but it is probable that it will exceed $100,000 per mile—and I congratulate "X" on the proof which this fact furnishes of the great success which is in store for this great enterprize.

Y.

EULOGIUM ON ENGINEERS.

The last number of "The Westminister Review" contains a very able article on the "Progress of Art," in which the writer complains of the want of originality among the architects of the present day, though he at the same time does justice to their merits. He points out several radical defects in the new houses of parliament, but intimates a doubt whether any other architect would have done better, evidently considering the profession in too low a state to undertake works of the first order. He says,

"It has been lucky for us that the ancients have left us fewer examples of their engineering works than productions of their architects. Our mediæval ancestors indulged but rarely in roads or bridges, and besides this, the exigencies of locality, and above all the exigencies of estimates, which are usually carefully looked at in the utilitarian works executed by our engineers, have allowed them less temptation to copy, and less means of doing so than their brother builders, and the consequence is that they may challenge Rome, or the whole world to match either the magnificence or the taste of our public works. It is true we possess some 'truly Roman works,' the taste of which is very questionable; and both Blackfriars and Waterloo bridges narrowly escaped being spoilt by the interference of the architects, who fortunately, however, have left nothing to mark their presence but the absurd Ionic, and the Grecian Doric columns that stand on the piers—in the one case supporting an enormously heavy granite parapet, and in the other in company with a most incongruous Roman balustrade. But since those days the engineering interest has acquired a predominance which enables it to walk alone; and in London bridge they have produced a specimen of bridge building, perfect in all its parts, and as yet unrivalled in the world, and this simply because there is not one detail copied from any other bridge, not one ornament applied that had not a meaning, nor one thing added that was not seen to be wanted by the sound sense and mechanical knowledge of its builders; yet there is a magnificence in this bridge amounting even to splendor, and could we point to one building in Great Britain built on the same principles of sound common sense, we should probably have to apply it to the same epithet.

"The names of Watt, Brindley, Smeaton, Telford and Rennie, or of our Stevensons, Brunels, Lindleys and Cleggs, are names to which an Englishman refers with pride, and stand in strong contrast with those of their contemporary builders of the present day; the former have contributed, as much as almost any class of men, to the advancement of civilization, and to the glory of the nation, and may almost be said to have created an art which is daily becoming of more and more importance. The latter, on the contrary, have done nothing to which we can refer with unmixed satisfaction, and much that has made us a laughing stock to surrounding nations.

"They have created nothing and advanced nothing; yet so closely do these professions approach at some points, that it is difficult to draw a line between them, and to say what works belong to one, and what to the other; but their mode of treating their subject differs as light does from darkness. The one admits of no rule but fitness and propriety, and the dictates of reason and common sense; the other, copying and disguising, never thinking of what is most fit or most useful, and worshipping the shadow of exotic art.

"Such an impulse has lately been given by our railways and canals to the science of engineering, that it now occupies almost as much of the public attention as architecture, and there is more probability of this influence increasing than diminishing, we may hope that the sound principles which have enabled engineers to execute such satisfactory works may extend to our architects, and that we may soon see some improvements in their designs; but much ignorance and long rooted prejudice must first be conquered, and, above all, the patrons of art must learn to take more interest in the subject than they have hitherto done, and to think more for themselves."

The Portsmouth (Ohio) Tribune says, that "Leander Ransom gives notice that the canal will be open its entire length on the 15th inst. We understand that double sets of hands are engaged on the culvert about six miles from Portsmouth, and the work is prosecuted both night and day. It will probably be completed in 6 or 8 days at farthest."

NEW YORK AND ERIE RAILROAD.

A large meeting of highly respectable citizens was held last evening at the Tabernacle, to devise means for aiding and urging on the construction of this important work. The following gentlemen were chosen to preside:

President,
GEORGE GRISWOLD.
Vice Presidents,

James Harper,	Wm. Tucker,	John H. Hicks,
John A. King,	Jas. Boorman,	J. DePeyster Ogden,
Thos. Suffern,	Robt. Smith,	P. S. Van Rensselaer,
C. W. Lawrence,	G. G. Howland.	Jacob Little,
Jas. Donaldson,	Saul Alley,	R. J. Carman,

Moses Taylor, Wm. Burns.

Secretaries,

Charles McVean, James Kelley, Charles Dennison,
Isaac Townsend, Chas. P. Brown.

Mr. JOSEPH BLUNT addressed the meeting in an earnest manner—urging the speedy construction of the road, and illustrated its importance to this city with the following, among other forcible arguments:

"The annual consumption of provisions by our city, amount in value to some $15,000,000, and many of the articles are furnished by the region bordering on the line of the Erie railroad more advantageously than from any other quarter—for instance, beef, of which the annual consumption is $1,500,000, and milk, of which the annual cost is about $1,000,000, one-third of which will be saved by the Erie railroad. The receipts of veal, poultry, game, butter, cheese, etc., by this road are already very large—of veal, 600 tons last year; of game, 1000 tons; of milk, 5000 tons, etc. All these articles have been cheapened to our city by this road, and the aggregate saving can hardly fall below $1,000,000 per annum, and, if the road were completed, would be nearer $2,000,000. If, then, this work would not pay any dividend, it would still be incumbent on us, and our obvious interest, to complete it."

Mr. Blunt closed his remarks by offering several resolutions for the appointment of a committee in each election district, and among the various professions and trades in the city with a view of presenting the subject in such a manner that every person may feel an interest in, and contribute to its success.

Mr. M. C. PATTERSON followed Mr. Blunt, and gave a glowing picture of the advantages to result from an early completion of the road. The following extracts from his remarks ought to be read by all who feel an interest in the progressive prosperity of our city. After referring in a proper manner to the present able board of directors, he says,

"They had found, after careful scrutiny, that the property of the company is now worth $4,000,000, and that $6,000,000 more will complete the work. Shall it not be completed? New York, lately so eminent, now labors under serious disadvantages in competing with her rivals for the trade of the mighty west. Boston, by means of her Western and other railroads, always in operation, presses her hard on the north. Philadelphia, by her vast net work of canals and railroads, enjoys decided advantages on the south. The milder climate of Pennsylvania secures to her three weeks' earlier opening and a week's later closing of her canals, as compared with those of our State. This year a boat from Ohio had reached Philadelphia three weeks before our canals opened. Baltimore is pressing forward with still greater advantages of climate. Charleston has also made a spirited attempt to pierce the great valley of the west. Can we afford to stand idle?" * *

"The 53 miles of the road now completed, running in good part near the Hudson, and forced to maintain a sharp competition with that cheap route, gave last year an income of $101,000, netting $46,000 over current expenses, from an area of 440,000 acres, having a population of about 40,000. Allowing the road when completed to yield in like ratio, and even reducing the nett product of last year one-third, or from $46,000 to $30,000, since it is found that some 12,000,000 acres (equal to the area of Connecticut, Rhode Island and Massachusetts) become directly tributary to this road on its completion, the annual earnings of the whole road must amount to $1,372,000! or no less than 15 per cent. on the capital invested!"

WM. B. OGDEN, Esq., of Chicago, also addressed the meeting—giving an interesting description of the growth and resources of the west; and of the interest felt by the people of that vast region in the success of this work—assuring the meeting that, if able, they would construct it at their own expense rather than have it fail.

The meeting was large, and appeared to be animated by the right feeling; and it is to be hoped that a similar spirit may be soon found to pervade this entire community.

The report of the directors published in February last ought to be in the hands of every business man in the city. The following synopsis of it gives its prominent points, and it should be read with care—and then there port itself should be examined.

SYNOPSIS.

The length of the road is 451 1-2 miles—64 miles of which are finished, and 53 miles in actual operation.

177 miles have been graded and bridged, and are ready for the superstructure.

The exact location of 350 miles has been determined on, and the right of way for 395 miles obtained.

The whole amount of expenditure upon the road is $4,716,872 66.

The whole amount of capital stock subject to dividends is $1,501,830 14.

The total amount of the indebtedness of the company is about $600,000.

The total cost of completing the road is estimated as follows:

For completing the track for use, - - - - - - -	$6,000,000
The outfit for commencement of business, viz: for depots, water stations, engines, cars, etc., - - - - - - - - - -	1,000,000
Making the whole sum required, - - - - - - -	$7,000,000
To which add amount of indebtedness, - - - - - - -	600,000
" " capital stock, - - - - - - -	1,501,830
Making the total amount of capital stock when the road is completed, -	$9,101,830

The board estimates that the property which this capital stock will own, could not have been acquired for less than 11,000,000 dolls.

The report is accompanied by a map delineating an area of country which will be tributary to the road in its transportation of freight and passengers. That area embraces about 12,000,000 acres and contains a population of 531,000 inhabitants.

The population tributary to the Erie canal in 1820 was 521,311, and in 1825, when it was first opened, 681,725.

The area of Massachusetts, Rhode Island and Connecticut is 8,660,000 acres, and the amount expended for railroads in those States is 25,000,000 dolls.

Of the indebtedness of the company the report states that the only sum which can embarrass its operations within five years has been reduced to less than 100,000 dollars, and that the board has succeeded in obtaining a surrender of the assignments and in recovering possession of the road and the other property of the company; and although "some difficulty may still grow out of the indebtedness not settled, yet, trusting to the assurances given by the parties almost without exception to extend to the company all the time that the ultimate security of these debts will permit, the board believe that it will be possible to make arrangements that will prevent any embarrassing prosecution of the claims during the period that measures for the resumption of the work are under consideration and action."

The company has also been relieved from all connection with past contracts and questions of damages.

During the year ending the 1st April, 1844, the total nett earnings of the 53 miles in operation from Piermont, on the river, to Middletown, in Orange Co., 7 miles of which was not completed until June, 1843, will be 46,800 dollars, making a reasonable estimate for the last two months. The extreme end of this portion of the road is only 20 miles from the river, and the whole 53 miles, therefore, subject to great competition, which diminishes, and finally ceases, as the road penetrates the interior.

"The board agrees with those who have preceded them in similar investigations, in considering that the population, products and area of the country, whose travel and transportation can be commanded, form a basis of calculation of all others most to be relied on."

They therefore present tables of articles transported during six months ending September 30th, 1843, over the 53 miles in use; and the table, compiled from the last census of the United States, of the population and products of the counties tributary to the road.

From these tables it has been inferred that about one-fourth of the nett earnings are of a local character, and that the surplus products in proportion to the population, fully equal those of Orange and Rockland. To enable a calculation of the probable productiveness of the road to be made on the basis mentioned, the entire area of country through which the road passes, has been subdivided into districts, whose centres are successively 50 miles apart on the line of the road, and the area and population of each district have been ascertained, upon which principle a calculation is thus illustrated:

1. The total amount of nett earnings from a population of 40,000 being 40,000 dollars; 30,000 may be taken as the basis of the calculation.

2. Instead of taking the full amount that might be deducted from the calculation of relative population and distances, two-thirds of that amount is assured.

And the result is the sum of $1,343,500 as the total nett earnings of the whole road, which is equal to a revenue of 15 per cent. on the total amount of capital.

The revenue that is expected to accrue from the transportation of the mails, and which will not probably be less than 100,000 dollars per annum, is not included in the above nett earnings. Neither is an allowance made for the increase of population; the business that must inevitably be brought to the road from the lakes; nor the diminished expense of transportation as the length of the road is increased.

The exports and imports of Buffalo during the year 1843, were 23,700,000 dollars.

It appears that passengers can be conveyed by this road from lake Erie to the city of N. York, in from 24 to 26 hours at a charge of 10 dollars each, and will afford a profit of from 3 to 5 dollars; that light freight can be transported in the same space of time, and heavy freight in from 48 to 50 hours, yielding a profit at low rates of from 3 to 10 dollars per ton. Passengers are now conveyed from Buffalo to New York during the summer in from 35 to 40 hours at a charge of $11 50, and during the winter by the Housatonic railroad in 40 hours, at a charge of 16 dollars, both exclusive of expenses on the road; and from Buffalo to Boston in 36 hours, for 15 dollars.

During the six months ending Sept. 30th, 1843, 3,000,000 quarts of milk—equal to 6,000,000 dollars per annum—were brought over the eastern division of the road, for which the consumers paid 4 cents a quart. Before a supply was obtained through this source, the average price was 6 cents a quart; an annual saving is therefore effected to the city on the amount brought, of 120,000 dollars; estimating the whole consumption of the city at 16,000,000 of quarts, the saving on the whole would be 320,000 dollars.

A table is given, showing the amount of country produce annually consumed in the city of New York, the value of which is put down at 15,500,000 dollars.

The whole amount that will be required to complete the road is 7,600,000 dollars; and with respect to the method of raising that sum the directors remark, that "the act of 1843 authorizes the company to issue bonds to the amount of 3,000,000 dollars, which *resource*, however, will not be an available one until further expenditures on the road shall make the property of undoubted security to the bondholders; nor until the means of paying the interest on these bonds is found within the resources of the company." They "are of opinion that subscriptions to the amount of 6,000,000 of dollars to the capital stock of the company must be obtained before any steps can be taken for the resumption of the work, and that with such subscription the completion of the road is secured with all reasonable certainty."

The road runs within 20 to 30 miles of the great anthracite and bituminous coal region in the northern counties of Pennsylvania.

Access will be had from it to the immense beds of gypsum or plaster, so valuable to the agriculturist, and also to the salt region of Onondaga by the interior lakes of the State, the Chemung canal and the Ithaca and Owego railroad.

At 375 miles from New York the road will connect with the Allegheny river, which is navigable for descending freight during the months of April and May, and by which route merchandize can be delivered in Pittsburgh in about 7 days.

Tables are given showing the immense increase of late years in the tonnage on the upper lakes, and in the amount of property coming from other States and shipped at Buffalo and Black Rock. The number of tons of property that came from other States and was received at these two places increased from 36,273 tons in 1836, to 224,166 tons in 1843.

The board, in expressing its opinion that the New York and Erie railroad will afford advantages not possessed by other avenues, and that its construction is of great importance to our city, enters into an enumeration of those advantages; but as they are too voluminous for a synopsis, the reader is referred to the report itself.

IRON SHIPS.

We had the pleasure of witnessing the launch of an iron steam ship, built for the revenue service by Messrs. H. R. Dunham & Co., Archimedes works, under the superintendence of Capt. Howard, U. S. N. The engines are by another firm. She has a single propeller, and is to be full ship rigged. Her model struck us as being remarkably fine, and so just are her proportions, that it was difficult to believe her capacity to be above three hundred tons. We had flattered ourselves with the hope of presenting our readers with a minute account of both hull and engines, but are only enabled to give the former at present, though we hope in our next to give full accounts of several other iron ships, and small craft, now constructing in this port. The following are the dimensions of hull and material:

Length on deck, 140 feet. Breadth, 24 feet. Depth of hold, 11 feet. Tonnage, 340 tons.

The size of the ribs, $4\frac{1}{2}\times\frac{3}{8}$; 20 inches apart from centre to centre; connected to the skin with 3 inch $\times\frac{3}{8}$ knees, on each side of rib, on every longitudinal seam. The skin of the vessel on the floor and each end including upper streak, is of $\frac{3}{8}$ inch plates; other parts $\frac{5}{16}$ inch full.

There are two water tight bulkheads, which include the engine, boiler and coal, making three water tight compartments in the hull. These communicate with each other by means of slide valves, which, in case of leakage, can be instantly closed. Connected with the forward of these are the coal bunkers, which are riveted to the bottom of the vessel and extend upward to the deck, where they are secured to the beams.

The deck beams are of angle iron, 5 inches on one side by $1\frac{3}{4}\times\frac{5}{8}$ thick, to which the deck is secured by means of bolts and nuts—in a very solid and superior manner.

TO THE SUBSCRIBERS OF THE AMERICAN RAILROAD JOURNAL.

The undersigned, during his connection with this Journal, having engaged in other pursuits, necessarily occupying much of his time, has been frequently prevented from giving that attention to the work which its interests demand. He now finds it expedient to devote himself entirely to his other avocations, and accordingly, having disposed of his interest in the proprietorship, his duties, as editor and proprietor, cease with the present number.

Having for more than eight years used the editorial *we*, he begs permission, on relinquishing it, to say a few words in propria persona. When the undersigned first became connected with this work, the railroad cause was rapidly advancing under the united forces of its own merits, and the common stimulus then operating upon every species of enterprize. That the tide soon turned, we all know—its effects upon the community generally, and upon the railroad cause, will not be soon forgotten. The trials experienced in sustaining the Journal, and the loss to its owners, are fully known only to those most interested—they need not be repeated for the edification of others. Meanwhile the good cause has passed through such an ordeal as seldom tries undertakings of like character; it is now unaided by any undue stimulus, but its own merits are acknowledged fully and universally, and by their help alone it is rapidly entering upon a healthy prosperity. The untiring labors of zealous friends of the cause have sucessfully contended with the host of adverse circumstances belonging to this disastrous period. To these friends the Railroad Journal has mainly owed its continued existence—not only have they enhanced the value of its pages by their contributions—but encouraged and sustained its publishers by the substantial aid of promptly paid subscriptions.

The undersigned would leave undischarged an imperative but welcome duty, were he to pass by this opportunity of gratefully acknowleding these various acts of kindness, shown to him as connected with the Journal. But more than this he feels bound to say. In his personal intercourse with the members of the profession, and others interested in railroads, he has uniformly received the most courteous treatment, and has, in many instances, been led into association with those whose friendship he flatters himself will outlast his formal connection with the Railroad Journal.

By a transfer of his share of these kindly offices to Mr. Minor, the friends of the undersigned will not only confer a personal obligation, but likewise aid in the just and proper restoration of these favors to their original recipient,

In no way can the well wishers of the Journal render it more important aid than by frequent contributions to its pages, while from the number of those already enlisted among its regular contributers, its increasing interest and value may be found guaranteed.

Although released from all charge over the Journal, the undersigned will remain as much attached to its interests as ever, and also proposes, as far as other engagements will allow, to continue to write for its pages.

In conclusion, the subscriber offers his best wishes for the health and prosperity of the friends, subscribers and worthy conductor of the American Railroad Journal. Long may it flourish. Success to the railroad cause.

George C. Schaeffer.

From the preceding valedictory, the readers of the Railroad Journal will learn that Mr. George C. Schaeffer, who has, for the past eight years, been the principal editor, withdraws from his post. In parting thus with an associate and friend, who so long stood by my side, while I was able to sustain my position; and who, manfully and alone for years, in behalf of the Journal, breasted the storm which prostrated me, with many of its early friends, until I could again come to its aid, with renewed energies, I feel called upon to bear testimony, as well to his uniform kindness and courtesy, in our business relations, as to his ability and discretion in the discharge of his editorial duties. When Mr. Schaeffer first entered upon his duties as editor, the condition and prospects of the railroad system, and hence of the Railroad Journal, seemed to warrant the opinion that his efforts in the cause would meet with a liberal reward; but I regret to say that such has not been the result, and therefore I cannot complain, however much I may regret, that he relinquishes his station to seek another which may yield him a better return; and in taking leave of him as an associate, after so long a period of constant and harmonious intercourse, amid the trying scenes of the past seven years, I cannot refrain from expressing my ardent hope that he may be successful in his present pursuits, even in proportion to his sterling merits—a measure of reward, which, if realized, will yield him all that is desirable in life.

One word, now, in relation to the future course of the Journal. As heretofore, it will be mainly devoted to the cause of internal improvements, and especially of railroads. Its columns will, however, be open to a free and full discussion of the merits of the different systems, and of different works. Truth, being mighty, is sure ultimately to triumph, as I believe railroads are destined to, over every obstacle; and to become, in this country, the bonds of union and the roads to wealth, the increased intelligence and happiness of the people.

Entertaining these views, and believing that we have had, in this country, ample experience, without referring to Europe, to establish their superiority over every other mode of intercommunication, I hope, with the continued aid of those friends, and my late associate, who have labored so ardently for the cause, together with others who have promised their co-operation, to make the Railroad Journal the appropriate medium for disseminating the results of the experience of our numerous able and scientific engineers, and machinists; and thus to command the liberal patronage of those whose interests are so largely identified with the system. A few copies of this number will be sent to friends of the cause, in different parts of the country, with the hope of securing their aid in its more general circulation; and should it meet with a cordial reception and prompt return, I shall be encouraged to renewed, and, I trust, successful efforts to make it still more useful than it has hitherto been.

D. K. Minor.

We have only space to acknowledge the receipt of the report of the Baltimore and Susquehannah railroad company for 1843—the "report of the engineer on the route surveyed for the northern railroad, from Concord to Lebanon, N. H."—the "proceedings of the stockholders of the Louisville, Cincinnati and Charleston railroad company—and of the south western railroad bank"—and also of the pamphlet of "Examiner," in relation to the Reading railroad—all of which we shall look into and perhaps refer to again.

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AMERICAN

RAILROAD JOURNAL,

AND

MECHANICS' MAGAZINE.

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For the American Railroad Journal and Mechanics' Magazine.

GENERAL PRINCIPLES AND INVESTIGATION OF FORMULÆ.

In making excavations through earth, it is customary to give some inclination or slope to the sides of the cuts to prevent the banks from sliding in and filling the roadway. The degree of inclination is always indicated by the distance the slope recedes from a perpendicular in a height one.

Thus, if the deviation from the perpendicular is equal to the depth of the cut, (or the inclination is 45°,) the side banks are said to have a slope of 1, or, as it is frequently expressed, of 1 to 1. If the deviation is ½ the depth, the slope is ½ to 1.

In excavations through rock, or very hard clay, a slope of ¼ to 1 is generally used; common earth stands at a slope of 1 to 1, but very sandy soil requires a slope of 1½ to 1. The section of an embankment is precisely similar to that of an excavation inverted, and therefore all the rules, formulæ and tables are alike applicable to both descriptions of work.

In embankments it is not considered prudent ever to adopt a less slope than 1½ to 1, unless the earth is supported by side walls.

In explaining the methods we use for the calculation of the solid contents of earth work, we shall first consider those cases where there is no slope in the ground transversely, or at right angles to the direction of the centre line of the road.

Let D be the depth of an excavation at any point,

B the width of the base,

m the slope of the side banks or distance they recede from the perpendicular in a height one.

Then $B + 2\,m\,D$ = width of excavation on top,

$B + m\,D$ = average width,

and $(B + m\,D)\,D$ = area of the cross section.

Hence if the depth were uniform throughout a length L the content would be

$$(B + m\,D)\,D\,L \quad - \quad - \quad - \quad - \quad - \quad - \qquad (A)$$

From this expression the tables of average depths are calculated.

We will now suppose D and d to be the depths at the two extremities of an excavation, the surface being understood to vary uniformly between these

points. Then the content of the included solid will be found by multiplying the sum of the end areas and four times the area of a middle section by one-sixth of the length. (See page 141 Bonnycastle Mensuration.)

The end areas are $(B + m\ D)\ D,$

and $(B + m\ d)\ d,$

four times the area of middle section $2\ B\ (D + d) + m\ (D + d)^2.$

Hence the content is

$$\left\{3\ B\ (D + d) + m\ D^2 + m\ d^2 + m\ (D + d)^2\right\}\frac{L}{6}$$

$$= \left\{6\ B\ (D + d) + 4\ m\ D^2 + 4\ m\ D\ d + 4\ m\ d^2\right\}\frac{L}{12} \quad - \quad - \quad (B)$$

Now the content of a cut of an uniform depth throughout of $\frac{1}{2}\ (D + d)$, found by substituting $\frac{1}{2}\ (D + d)$ for D in equation (A) will be

$$\left\{B + \tfrac{1}{2}\ m\ (D + d)\right\}\frac{D + d}{2} \times L$$

$$= \left\{6\ B\ (D + d) + 3\ m\ D^2 + 6\ m\ D\ d + 3\ m\ d^2\right\}\frac{L}{12}.$$

The difference between this content for the average depth of $\frac{1}{2}\ (D + d)$, and the content of a cut the depth of which is D at one end, and d at the other, as given in formula (B,) is

$$(m\ D^2 - 2\ m\ D\,d + m\ d^2)\frac{L}{12},$$

$$\text{or} \qquad (D - d)^2\,\frac{m\,L}{12}. \quad - \quad - \quad - \quad - \quad (C)$$

It appears from this, that the correction to be added to the content obtained from the average depth, varies as the square of the difference of the depths at the two extremities of the excavation; and that, therefore, if a table is calculated expressing the values of equation (C) for different values of $(D - d)$ we can readily ascertain the content of any excavation, by addition of the numbers taken from this table to the content found in the table of average depths and corresponding to a depth of $\frac{1}{2}\ (D + d)$.

The tables numbered VII, XIV and XXI, and headed "*Corrections for Differences*," are computed from formula (C), and adapted to this purpose.

It is customary with many engineers to multiply the half sum of the end areas by the length for the content. The half sum of the end areas multiplied by the length is

$$(B\ D + B\ d + m\ D^2 + m\ d^2)\frac{L}{2}$$

$$= \left\{6\ B\ (D + d) + 6\ m\ D^2 + 6\ m\ d^2\right\}\frac{L}{12}$$

from which deduct the true content as in equation (B), and there remains

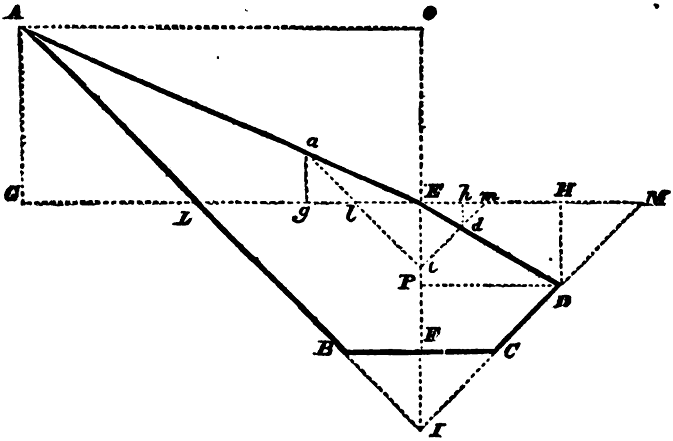
$$(2\ m\ D^2 - 4\ m\ D\ d + 2\ m\ d^2)\ \frac{L}{12} = (D - d)^2\,\frac{m\ L}{6}.$$

It will be perceived that the amount of error is exactly double the whole

"correction for differences." In a cut 100 feet long, 30 feet deep at one end, and 3 feet at the other, having a slope of $1\frac{1}{2}$ to 1, there would be an excess in the return of work thus estimated on this short distance, of 675 cubic yards.

We will now consider those cases where there is an inclination in the natural surface of the ground in a direction at right angles to the centre line of the road.

Fig. 1.



Let A B C D E (fig. 1) be a transverse vertical section of an excavation, where B C is the base, A B and C D the sloping sides, E F the centre cutting, and A E D the natural surface. Draw L E M parallel to B C (cutting the side slopes at L and M), and A G and D H perpendicular to it. Since the area A B C D = L B C M + A E L — D E M, the content of a prism whose base is A B C D, and length L, may be found by adding to the content of the prism having the base L B C M, (which will be taken from the table of averages,) the difference of the prisms whose bases are the triangles A E L and D E M respectively. But area A E L = $\frac{1}{2}$ E L × A G and area E D M = $\frac{1}{2}$ E M × D H. Hence $\frac{AG - DH}{2} \times EL \times L$ is the correction for the transverse slope, which must be added to the average content to give the true content of the solid whose section is the figure A C. When the depth of cutting at the points A and D has been ascertained, A G and D H are known, being the difference of elevation of the points A and D and the centre E. We may also remark that E L or E M is equal to B F + m × E F. Where the inclination of the ground is not very great, it will be found sufficiently accurate for all purposes, and much more expeditious, after having run the centre line to take the transverse slope in degrees right and left of the centre. Wm. J. Young, of Philadelphia, has made a very neat little slope instrument expressly for this purpose.

When the transverse slopes have been ascertained in degrees, the corrections will be found by means of a table which will now be explained.

Produce A B, E F and D C until they meet in I. On E I lay off E i = 1 and draw a i, i m parallel to A I and D I cutting A E, E L, E D and E M in a, l, d, and m; and draw a g and d h perpendicular to G M. Then the areas a i E, E d m are equal respectively to $\frac{1}{2}$ a $g \times$ E i and $\frac{1}{2}$ d $h \times$ E m, and are to be found under the head of greater and lesser areas in tables XXIII, XXIV, XXV and XXVI, for every degree of slope from 1° upwards. In the same tables under the heads of greater and lesser distances, will be found the values of a E, and E d also for every degree.

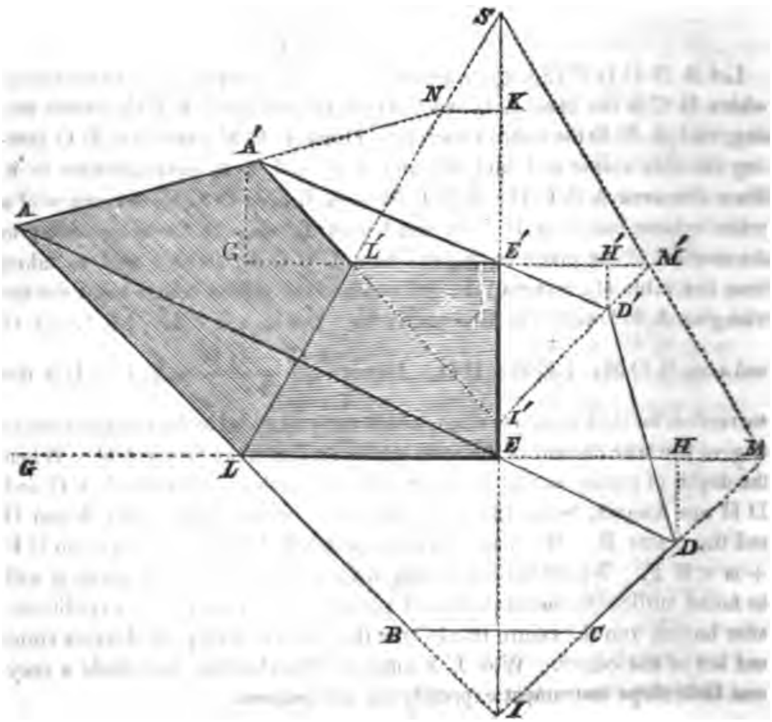
$$\text{Now,}\quad \begin{array}{l} E\,i\,(=1) : E\,I :: E\,a : E\,A = E\,a \times E\,I \\ E\,i \qquad\quad : E\,I :: E\,d : E\,D = E\,d \times E\,I. \end{array}$$

Hence the side distances E A and E D are found by multiplying E I by the numbers in the table opposite the given slope and under the greater and lesser distances.

Again, $(E\,i)^2\,(=1) : (E\,I)^2 :: (E\,l)^2 : (E\,L)^2 ::$ area l a E : area L A E = area l a E $\times (E\,I)^2$.

$(E\,i)^2 : (E\,I)^2 :: (E\,m)^2 : (E\,M)^2 ::$ area E d m : area E D M = area E d $m \times (E\,I)^2$.

Fig. 2.



Hence the true correction for a length L is $(l\ a\ E - E\ d\ m) \times E\ I^2 \times L$.

Now, $E\ I^2 \times L$ is the content of a square prism, whose base is E I, and length L; and table XXII shows the content in cubic yards of prisms 100 feet long for square bases from 1 to 200 feet. Hence the value of $E\ I^2 \times L$ reduced to cubic yards may be taken from this table.

It will generally be found sufficiently accurate to consider the average slope in degrees as the uniform slope, and the average depth as the uniform depth throughout the cut. But as this is not always the case, it is desirable to have a true expression for the correction where the depths of cutting (and consequently the width on top) and the transverse slopes are variable. We will then see how far a mean depth and slope may be used without introducing material errors into the results of our calculation.

Let A L E (Fig. 2) represent a vertical section of that part of an excavation which rises above the centre E, A L being the sloping side of the cut, and A E a section of the natural surface. Let A′ L′ E′ be a similar and parallel section situated at a distance E E′ from the plane A L E. On E L and E′ L′ produced, let fall the perpendiculars A G and A′ G′; produce E E′ and A A′ to meet L L′ produced in S and N and draw K N parallel to E L or E′ L′.

Put $E\ L = T,\ E'\ L' = T',\ A\ G = P,\ A'\ G' = P'$

$E\ E' = x,\ E\ S = M$ and $E\ K = M'$.

Then $E\ S : E'\ S :: E\ L : E'\ L'$,

or $M : M - x :: T : T' = T - \frac{T\ x}{M}$.

and $E\ K : E'\ K\ (:: L\ N : L'\ N) :: A\ G : A'\ G'$,

that is $M' : M' - x :: P : P' = P - \frac{P\ x}{M'}$.

Now the area $A'\ L'\ E' = \frac{1}{2}\ T'\ P' = \frac{1}{2}\left(T\ P - \frac{T\ P\ x}{M'} - \frac{T\ P\ x}{M} + \frac{T\ P\ x^2}{M'\ M}\right)$

But if S = content of the solid E A′ the differential of $2\ S = 2$ area $A'\ L'\ E' \times d\ x = T\ P\ d\ x - \frac{T\ P\ x}{M'}\ d\ x - \frac{T\ P\ x}{M}\ d\ x + \frac{T\ P\ x^2}{M\ M'}\ d\ x$.

Hence by integrating this equation we have

$$2\ S = T\ P\ x - \frac{T\ P\ x^2}{2\ M'} - \frac{T\ P\ x^2}{2\ M} + \frac{T\ P\ x^3}{3\ M\ M}.$$

Substituting for M and M′ in this equation their values $\frac{T\ x}{T - T'}$ and $\frac{P\ x}{P - P'}$ and putting L for x we have

$$S = (2\ T\ P + 2\ T'\ P' + T'\ P + T\ P')\ \frac{L}{12} \quad \cdot \quad \cdot \quad (D)$$

This is a general expression for the content of a solid bounded on two sides by planes, and on the third by a warped surface.

If B C (fig 2) represents the base B, $I\ F = \frac{B}{2\ m}$, $E\ I = D + \frac{B}{2\ m} = H$

and $E' I' = H'$, then $T = E L = m \times H$ and $T' = E' L' = m \times H'$. These values of T and T' substituted in the last equation give us for the content

$$(2 H P + 2 H' P' + H' P + H P') \frac{m L}{12},$$

which is the excess in cutting caused by the slope of the ground rising above the centre line of the excavation; and if H D and H' D' (fig. 2) be put $= p$ and p', the deficiency caused by the slope falling below the centre will be

$$(2 H p + 2 H' p' + H' p + H p') \frac{m L}{12},$$

and the true correction is evidently equal to the difference of these expressions, or

$$\left\{ (2 H + H') (P - p) + (H + 2 H') (P' - p') \right\} \frac{m L}{12} \quad \cdot \quad (E).$$

Had we taken $\frac{P + P'}{2}$ in place of P and P', and $\frac{p + p'}{2}$ for p and p', or the mean of the perpendiculars P, p, P' and p', the correction would have been

$$(H + H') (P - p + P' - p') \frac{m L}{8} \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad F,$$

which if substracted from equation (E) leaves a second correction

$$(H - H') (P - p - P' + p') \frac{m L}{24} \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad (G).$$

These are in a more convenient form than equation (E), as (G) may, when of little importance, be omitted.

When $P - p = P' - p'$ equation (E) becomes

$$(H + H') (P - p) \frac{m L}{4} \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad (H).$$

When the depth is uniform but not the slope we have

$$H (P - p + P' - p') \frac{m L}{4} \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad (I).$$

And finally, when slope and depth are both uniform.

$$H (P - p) \frac{m L}{2} \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad (K).$$

These expressions for "corrections for transverse slopes" are in the most convenient form, if the heights of the points A and D (figures 1 and 2) are found without the use of the slope instrument, and they do not require the use of the tables.

Let $P = \frac{2 A H}{m}$, $p = \frac{2 a H}{m}$, $P' = \frac{2 A' H'}{m}$ and $p' = \frac{2 a' H'}{m}$, (where A, a, A' and a' are the areas A L E, E D M, A' L' E' and E' D' M' (fig. 2) when H and H' are each $= 1$) then expression (E) becomes

$$\left\{ 2 H^2 (A - a) + 2 H'^2 (A' - a') + H H' (A - a + A' - a') \right\} \frac{L}{6};$$

which, if we assume the slope uniform throughout the excavation, becomes

$$\left\{ H^2 + H'^2 + (H + H')^2 \right\} (A - a + A' - a') \frac{L}{12}, \quad \text{(L)}$$

and this subtracted from the above equation leaves us a second correction

$$(H^2 - H'^2)(A - a - A' + a') \frac{L}{6}. \quad \text{(M)}$$

When the slope is uniform throughout, our expression becomes

$$\left\{ H^2 + H'^2 + (H + H')^2 \right\} (A - a) \frac{L}{6}. \quad \text{(N)}$$

But if we had taken the mean depth $\frac{H + H'}{2}$ as the uniform depth we should have had for the correction

$$(H + H')^2 (A - a) \frac{L}{4},$$

which subtracted from equation (N) leaves a remainder

$$(H - H')^2 (A - a) \frac{L}{12}. \quad \text{(O)}$$

When the depth is uniform, but not the slope, we have

$$H^2 (A - a + A' - a') \frac{L}{2}. \quad \text{(P)}$$

And when the slope and depth are both uniform

$$H^2 (A - a) L. \quad \text{(Q)}$$

These expressions for "corrections for transverse slopes" are useful when the slopes are taken in degrees, and their values can readily be found by means of the tables of areas and table XXII.

There is another method of calculating the contents of excavation and embankment, which is more convenient when the slopes are very great and the depths variable, which will now be explained.

In fig. 1, draw A O and D P parallel to B C, meeting I E and I E produced in O and P. Put $E I = H$, $A O = W$, and $D P = w$, and let the corresponding dimensions of a parallel section situated at a distance L from A D I be represented by H' W' and w' respectively.

By substituting H and W for T and P, and H' and W' for T' and P' in equation (D), we have for the content of the solid included between A E I and its corresponding section

$$(2 H W + 2 H' W' + H' W + H W') \frac{L}{12},$$

and the content of the solid formed on D E I is

$$(2 H w + 2 H' w' + H' w + H w') \frac{L}{12}.$$

From the sum of these contents subtract the content of the prism having for a base the triangle B C I and we have for the content of the solid formed on A B C D.

$$\left\{ (2 H + H')(W + w) + (H + 2 H')(W' + w') \right\} \frac{L}{12} - \frac{B^2 L}{4 m}. \quad \text{(R)}$$

Let Y, y and Y′ y' represent the ratio of W. w, and W′, w' to H and H′ respectively on the values of W, w and W′, w' when H and H′ are each = 1. Then by substitution the above equation for the content becomes

$$\left\{ 2 H^2 (Y + y) + 2 H'^2 (Y' + y') + H H' (Y + y + Y' + y') \right\} \frac{L}{12} - \frac{B^2 L}{4 m}.$$

If we assume the slope as uniform we have for the content

$$\left\{ H^2 + H'^2 + (H + H')^2 \right\} (Y + y + Y' + y') \frac{L}{24} - \frac{B^2 L}{4 m}, \quad \text{(S)}$$

which subtracted from the above equation leaves a remainder

$$(H^2 - H'^2)(Y + y - Y' - y') \frac{L}{12}. \quad \text{(T)}$$

When the transverse slope is constant the content is

$$\left\{ H^2 + H'^2 + (H + H')^2 \right\} (Y + y) \frac{L}{12} - \frac{B^2 L}{4 m}. \quad \text{(V)}$$

If the depth is uniform but not the slope the content is

$$H^2 (Y + y + Y' + y') \frac{L}{4} - \frac{B^2 L}{4 m}. \quad \text{(W)}$$

When the slope and depth are both uniform

$$H^2 (Y + y) \frac{L}{2} - \frac{B^2 L}{4 m}. \quad \text{(X)}$$

The values of Y y Y′ and y' for every degree of slope from 1° upwards are given in tables XXIII, XXIV, XXV and XXVI under the head of greater and lesser horizontal distances and by means of these and table XXII the values of these equations can easily be ascertained.

If there is no transverse slope we will have

$$\left\{ \frac{(H + H')^2}{2} + \frac{(H - H')^2}{12} \right\} m L - \frac{B^2 L}{4 m}. \quad \text{(Y)}$$

Here it may be observed that the value of $\frac{(H - H')^2}{12} m L$ is given in the table of "corrections for differences No. XIV * and that the other terms of the equation are found in table XXII.

Finally, if there is no slope and no variation in depth the equation becomes

$$H^2 m L - \frac{B^2 L}{4 m}. \quad \text{(Z)}$$

NOTE. If H^2 or H'^2 is substituted for $(H - H')^2$, this remark will apply to all the formulæ in which L is divided by 12. The numbers in table XIV are $\frac{1}{12}$ of those in table XXII. If $m = \frac{1}{2}$ or $= 1\frac{1}{2}$ the expression $\frac{(H - H')}{12}$ m L will be found in table VII or XXI, but if m is any other number, the expression must be found in table XIV and multiplied by m.

ON THE CALCULATION OF THE TABLES.

The labor of forming tables for calculating earth work may be very much abridged, by obtaining the first and second differences.

In any expression of the form $a\,x + b\,x^2 = n$, let x be increased by a constant quantity y and become $x + y$, $x + 2\,y$, $x + 3\,y$, $x + 4\,y$, etc.: then the successive values of n will be

$$a\,x + b\,x^2$$
$$a\,x + a\,y + b\,x^2 + 2\,b\,x\,y + b\,y^2$$
$$a\,x + 2\,a\,y + b\,x^2 + 4\,b\,x\,y + 4\,b\,y^2$$
$$a\,x + 3\,a\,y + b\,x^2 + 6\,b\,x\,y + 9\,b\,y^2$$
$$a\,x + 4\,a\,y + b\,x^2 + 8\,b\,x\,y + 16\,b\,y^2, \text{ etc.}$$

Take the difference between each of these expressions and the following one, and we have

$$a\,y + 2\,b\,x\,y + b\,y^2$$
$$a\,y + 2\,b\,x\,y + 3\,b\,y^2$$
$$a\,y + 2\,b\,x\,y + 5\,b\,y^2$$
$$a\,y + 2\,b\,x\,y + 7\,b\,y^2$$

These are called the first differences and the difference of these differences

$$2\,b^2\,y$$

is called the second difference.

Hence commencing with the first of the first differences, the continued addition of the second diffenence produces the seveta1 first differences, and these added in order to the first value of n will give the successive values of n. If the equation is of the form $b\,x^2 = n$, or a becomes o, then the first difference is $2\,b\,x\,y + b\,y^2$, and the second difference is $2\,b\,y^2$, as before found.

Let us apply this method to the calculation of the tables of contents for average depths. The expression for the content is (equation A)

$$(\mathrm{B} + m\,\mathrm{D})\,\mathrm{D\,L} = \mathrm{B\,L\,D} + m\,\mathrm{L\,D}^2.$$

Hence if we suppose D to be increased constantly by a quantity d, the 1st first-difference, found by substituting D and d for x and y, and B L and m L for a and b will be

$$(\mathrm{B}\,d + 2\,m\,\mathrm{D}\,d + m\,d^2)\,\mathrm{L},$$

and by a similar substitution we shall find for the second difference

$$2\,m\,d^2\,\mathrm{L}.$$

Let it be required to calculate the contents answering to every foot in depth for a length of 100 feet, base of 25 feet, and slope of ½ to 1.

Here B = 25, L = 100, $m = \frac{1}{2}$, D = 1, and $d = 1$, and since these quantities are given in feet, our several results must be divided by 27 to reduce them to cubic yards.

$$\text{Now } (\mathrm{B} + m\,\mathrm{D})\,\mathrm{D\,L} = \frac{25{\cdot}5 \times 100}{27} = 94{\cdot}444 = \text{content for one foot.}$$

$$(\mathrm{B}\,d + 2\,m\,\mathrm{D}\,d + m\,d^2)\,\mathrm{L} = \frac{26{\cdot}5 \times 100}{27} = 98{\cdot}148 = \text{1st first difference.}$$

And $2\,m\,d^2\,L = \frac{100}{27} = 3{\cdot}7037$ = second difference.

Hence the table will be calculated as exhibited below; the first differences being severally formed by addition of the second difference to the preceding one, and the table of contents by the addition of the corresponding first difference to the preceding content.

Depth feet.	First Dif. cub. yds.	Content. cub. yds.
1		94·444
2	98·148	192·592
3	101·852	294·444
4	105·556	400·000
5	109 529	509·259
6	112·963	622·222
7	116·667	738·889
8	120·731	859 260
9	124·074	983·333
10	127·778	1111·111

Let us apply this method to the calculation of a table of corrections for differences and in the equation (C) $(D - d)^2 \times \frac{m\,L}{12}$ put D′ for D — d and let it be constantly increased by a given quantity d'. Then

$$(2\,D'\,d' + d'^2)\,\frac{m\,L}{12} = \text{1st first difference,}$$

and $$\frac{d'^2\,m\,L}{6} = \text{second difference.}$$

If L = 100, D′ = 1, d' = 1, and m = 1, the 1st first difference reduced to cubic yards is ·92593, and the second difference reduced also to cubic yards is ·61728. Hence the table will be calculated as follows:

Dif. of depth in feet.	First dif. cub. yds.	Correction cub. yds.
1		·30864
2	·92593	1·23457
3	1·54321	2·77778
4	2·16049	4·93827
5	2·77778	7·71605
6	3·39506	11·11111
7	4·01234	15·12345
8	4·62963	19·75308
9	5·24692	25 00000
10	5·86420	30·86420

For the American Railroad Journal and Mechanics' Magazine.

BEAR MOUNTAIN RAILROAD.

Having completed the location of the Bear Mountain railroad, and the work being now under contract, and in progress of construction, I have thought that a statement of our operations thus far, and a brief description of the general features of the road, might be interesting to the readers of the Journal.

This road is intended for the transportation of the Bear valley coal from the mines to the canal, and, as originally chartered, was to extend from Rausch Gap, in Schuylkill county, through Lykens valley, to the head of the Wiscinisco canal, (unfinished) nineteen miles above Dauphin. Previous to my taking charge of the survey, some instrumental examinations had been made to ascertain the feasibility and probable cost of the road through Lykens valley, and from these examinations, it was ascertained that a route could be obtained through this valley, with grades either level or descending from the mines to the canal, and with a maximum grade of 36 feet per mile.

The principal business which this road would probably transact, consists in the transportation of coal and iron in one direction, and the great rivalry now existing between the parties interested in the several coal regions, renders it necessary that the cost of this transportation should be as low as possible. In order to ascertain the practicability of obtaining a less objectionable route for the road than the one originally contemplated through Lykens valley, I was induced to give a most rigid and thorough examination to the several valleys which head near the western extremity of this coal field; and as the result of these examinations, we have adopted a route wholly different from the one originally contemplated, by which a saving of 14 miles of transportation is effected, with a termination at Dauphin, 19 miles lower down on the canal, and but 8 miles above Harrisburgh. In addition to this the road, as now located, has for its entire length (upwards of 30 miles) *a continuous descending grade of not less than* 16½, *nor more than* 17½ *feet per mile, with but two points on the line where the grade changes, and the minimum radius of curvature is* 1910 *feet.*

I am not aware that there is any railroad in the United States, or in the world, which, either for the whole, or any considerable portion of its length, is so admirably adapted for the cheap transportation of freight in one direction, and in fact, as far as the grades of a railroad affect the cost of transportation, I consider that our road is so located as to reduce this sum to a minimum.

It is difficult to say what is the greatest load that a locomotive could take down our road, but the average loads of an engine will of course be limited by the number or weight of empty cars with which it could return to the mines, ascending a grade of 17½ feet per mile.

It will readily be seen that our facilities for transacting a heavy freight business are greater than upon any railroad yet constructed. and that for the

peculiar kind of transportation, this road is over 40 per cent. better than a perfectly level road.

Our road has several other distinctive features; and is, in many other respects, of a most extraordinary character.

My business engagements at present, however, will not permit me to enter more into detail; but as soon as I have leisure, I shall be happy to furnish the Journal with sketches and drawings of several of our works of art, together with a more full description of the road and machinery.

J. SPAULDING,

Dauphin, April 18, 1844. *Chief Engineer B. M. Railroad.*

COAL TRADE.

We have received a pamphlet of some 70 pages on the "Reading railroad company," by "Examiner;" being "a series of articles published in the Pennsylvanian in January, February and March, 1844." The object is to counteract the "incendiary publications" issued in 1839 and 1840, by the Reading railroad company. The speedy downfall of this company is predicted with great confidence, and an elaborate demonstration is gone into—one of the main arguments being the rapid wear of the iron rails, a subject on which much has been written for this Journal. The pamphlet reiterates the old story about the "refuse rails" of the South Carolina railway, which has been positively contradicted by our correspondent "Q," in whose statements every confidence may be placed.

There is quite enough of the "incendiary" spirit in both of these rivals for the coal trade. If the capital of the railway be eight millions of dollars, then will it require 1,280,000 tons, netting 50 cents per ton, to pay the moderate interest of 8 per cent. The Schuylkill and other works will of course continue their contributions, and thus in order to make the Reading railway a successful work the consumption must be doubled at once.

The tolls on the Schuylkill canal are now 36 cents per ton, or 3 mills per ton per mile; the capital is about 3½ millions of dollars. To pay 8 per cent. on this sum, will require about 700,000 tons of coal per annum, exclusive of other sources of income. The Schuylkill canal carried last year 447,058 tons of coal, and "Examiner" estimates "the coal business of the Schuylkill field in 1844" at 800,000 tons. (p. 60). This is little more than enough for the canal, and only two-thirds of the quantity required by the railroad.

The pamphlet of the Baltimore and Ohio railroad company, published in this Journal, gives detailed estimates of the cost of transporting coal; the aggregate of all expenses being very nearly 9½ mills per ton per mile, exclusive of interest. They show that 1½ cent per ton per mile will yield a fair profit.

On the other hand, "Examiner," (p. 51) makes the following estimate for the Reading railway, per ton per mile, descending, including taking back the empty cars.

Locomotive power,	·429
Maintenance of way,	·662
Maintenance of cars,	·448
Miscellaneous charges,	·200
Total in cents,	1·739

This is very nearly twice the estimate of the Baltimore and Ohio company, endorsed by Mr. Latrobe. As time will shortly demonstrate which is the more reasonable view, further speculation is at this time useless, and we shall dismiss the subject after drawing attention to the following circumstance. In 1841 the Schuylkill canal brought down 584,000 tons, in 1843 only 447,058 tons which with the 229,015 tons per railroad, gives 676,073 tons from the "Schuylkill field" for that year. The railway was not doing enough to have any influence on the trade till last fall, yet the receipts of the canal fell from $575,000 in 1841 to $315,000 in 1842. The full price might have been maintained till late in 1843, and it looks very much as if the canal company to prevent the completion of the railway had literally thrown away nearly half a million of dollars, which would have paid dividends for 1842 and 1843, and left the company in a better state to compete with the railway. Had those entrusted with the direction of these works been actuated by the proper spirit, there could have been no difficulty in making an arrangement which would have yielded a fair profit to both. However much the public may appear to gain from the sacrifices made to injure each other, it entertains no other feeling than contempt for those who thus squander large sums confided to them by others for the purpose of securing fair dividends from undertakings calculated to advance the prosperity of the country.

In a late number, the statement of the Delaware and Hudson canal company for 1842 was given, and we now give the statement of this flourishing work for 1843.

Statement of the business of the Delaware and Hudson Canal Co. for 1843.

To coal on hand, March 1, 1843,	$124,691 50	By sales of coal,	$804,900 74
" Mining coal,	107,642 93	" Canal and railroad tolls,	30,996 53
" Railroad transportation and repairs,	103,808 02	" Interest received,	23,251 41
" Freight of coal to Rondout,	233,837 68	" Coal on hand,	71,054 25
" Canal repairs and superintendance,	77,700 23		
" Labor and expenses at Rondout,	21,219 50		
" Interest on State stock,	38,325 00		
" Interest on company loan,	2,349 00		
" Rents, salaries, current expenses, etc.	23,927 33		
Balance,	196,701 74		
	$930,202 93		$930,202 93
New York, March 1, 1844.		By balance,	$196,701 74

Hence it will be seen that the cost of transportation on the 108 miles of canal was $233,837, or 9½ mills per ton per mile, and the total cost from the mines, 126 miles, was 14½ mills per ton per mile. Deducting mining, interest, rents, etc., and the total charge may be taken at $2 80 per ton, or $·0222, or nearly 2¼ cents per ton per mile. The dividend amounts to 87½ cents per ton, about 7 mills per ton per mile, or more than twice the gross charges of the Schuylkill canal!

Lastly, it must be remembered that the railway, though only 16 miles

long, does one fourth of the work. The coal is mined on the west side of the mountains, and carried over the summit to the canal on the eastern slope, so that though only one-eighth of the entire line, it has to bear the brunt of the fight. In fact this work could scarcely exist without the railway, though we believe that the Schuylkill canal is not equally dependent on that mode of transportation.

The high rates of transportation—as compared with Philadelphia estimates—which coal affords on the works of the Delaware and Hudson canal company, show that that canal has peculiar advantages. The grand, the vital advantage is, that the work is complete in itself. The company owns from the mines to the Hudson, and can now deliver coal at tide water on that river as cheaply as it can be delivered in Philadelphia, if the *Miners' Journal* is correct in stating that the average cost of coal delivered in the cars or boats at Pottsville is, on an average, $2 25 per ton. We believe that no red-ash coal can be reached by any cheaper route than via the Delaware and Raritan canal, though the white-ash of the Wyoming field delivered on the Hudson at $3 50 per ton, yields 10 per cent. to the Delaware and Hudson canal company. Hence we conclude that no inconsiderable part of the coal trade will be from the mines to the Hudson, though we have no idea that the present trade of Philadelphia, or of the Delaware and Hudson canal company, is to be diminished by new avenues skillfully projected, and destined to accommodate the increasing demand, and not merely for the purpose of supplanting a useful flourishing work.

DUTY ON RAILROAD IRON.

The Pottsville Miners' Journal has a long article on *the iron trade*, in which the policy of keeping up the present duty of $25 per ton on railroad iron is warmly advocated. It is said that this article can be produced here for $55 per ton—but where? Can it be delivered in New York or Boston for that price? It is too generally overlooked that railways are, in many instances, more important to the manufacturer than any tariff. The cost of transportation of the materials, ore, coal, lime and manufactured article, is one of the grand items, and many works now abandoned would be in flourishing operation if they had a cheap communication, open throughout the year with the sea board. The immense capital required for the manufacture of railway iron, the uncertainty of the demand, and the very low profit it can afford under this branch of the iron trade the least desirable of all to the American iron master, as well as the very last in which he should engage. By means of railways establish the iron trade in all its most profitable branches, and then, when no other iron is imported, impose any duty on railroad iron which may appear at that time judicious; but do not now cripple the rising energies of this best friend of the farmer and manufacturer for the purpose of inducing enterprizing men to embark in the least profitable and most uncertain branch of the trade, while such enormous quantities of iron are imported for the common purposes of life.

THE SCREW PROPELLER—STEAM NAVIGATION.

At the last meeting of the Liverpool Polytechnic society, the president, John Grantham, Esq., E. C., in the course of his annual address, said, that finding he had but few observations to make on the state and prospects of the society—so even had been the tenor of its way through all the changing scenes of the times—he should introduce to their notice a topic of public interest, suited to the character of their meetings; the subject he alluded to was the present state of steam navigation. After some introductory observations, as to the failure of the science as a profitable mechanical speculation, he called their attention to the screw propeller, as a substitute for paddle wheels —an improvement which he had great hopes would do much to place steam navigation on a firmer foundation. Several short notices of the screw propeller had appeared in scientific publications, [See *Mining Journal* of the 28th October, for a detailed description, with diagram,] but they were very imperfect, and little could be gleaned from them. It had, however, been referred to more satisfactorily, in a paper written by Mr. Elijah Galloway, the patentee of paddle wheels, in an appendix to Tredgold's work on the steam engine. But the author had not formed a decided opinion on the question, and did not establish its superiority. The French claimed to be the original inventors of the screw propeller, and few would dispute with them the honor on this point—though they also claimed the steam engine, which was due to the English. The lecturer here referred to a French paper detailing the performances of the French war steamer *Napoleon*, which were certainly satisfactory; and next noticed a number of instances in which the screw had been employed, even from the year 1699. It was also tried by different parties in 1743 and 1763. In 1802, the *Doncaster* transport, which had been becalmed, was worked into harbor at Malta, at the rate of one and a half mile per hour, by eight men at a spell. She went seven leagues with a screw, and the parties seemed to have contemplated every kind of propeller since patented by others. In 1825, the screw was applied to a vessel in the Thames. In 1828, a patent was taken out for a screw by Mr. Chas. Cummerow. In 1832, M. Sauvage also applied it. In the same year, Mr. Woodcroft, of Manchester, took out his patent; in 1836, Mr. Smith his; and in 1838, Mr. Ericsson also obtained one. Cummerow's and Smith's were much alike. Mr. Grantham then explained the principle of the screw, or inclined plane, and its advantages over the paddle wheel, assuming for argument sake, that simply as a propeller, there was no preference to be given to either. He referred to cross sections of two vessels of the same dimensions, one with the paddles, and the other with the screw; also to longitudinal sections of the same. By pointing to this, he clearly showed the several advantages of screw vessels. There were several kinds of screw propellers, but the principle was the same in all—an inclined plane turned round a spindle, or cylinder. This he showed by wrapping a piece of paper in the form of a right angled triangle round a roller; and the hypothenuse, or slanting edge, of the paper, described the worm of the screw, which might be made of any pitch. And if a screw were made to revolve in a solid, by giving it one revolution, it would move forward or backward, a distance equal to the pitch. There might be several threads in the same screw, but although this constituted a difference in form, the principle remained unaltered. Mr. Smith's first experiments were made with a single thread, or incline, wound round an axis, making an entire revolution, and presenting to the eye, when looking in the direction of the axis, the form of a complete disk. Ericsson's and others consisted of a short portion of the screw, with many threads, or inclines, in some cases appearing to the eye,

when placed in the direction of the axis, as a complete disk. [He here described the number of blades on the screw, and how they were formed.] Woodcroft, who obtained his patent in 1832, adopted a slightly different system. Instead of the thread being uniform, and the incline the same at all points, he proposes an increasing pitch at the after end. His object would be understood by considering a fish's tail, more particularly that of the eel. In the evolutions made by its body and tail, they each continued to increase; and, consequently, the rapidity with which it struck the water increased also, and compensated for the loss of effect occasioned to the tail by the motion given to the water by the body. In like manner, by giving this constantly increasing angle to the screw, the same result would follow. This he, Mr. Grantham, conceived to be a very beautiful modification of the original screw propeller. The principle did not escape the attention of others; and it was to be regretted that it had not been tried earlier and made known. He had alluded to the plans of Messrs. Smith, Ericsson and Woodcroft, to the first two as being best known, and because he believed the award of superiority, was, by almost common consent, given to it. Mr. Smith was the originator of a company that built the Archimedes—a vessel that circumnavigated England, and performed other long voyages. She first drew public attention to the subject. Great credit was due to that spirited company, and to Mr. Smith, for these experiments, which were conducted on a liberal scale; but this was not the first vessel that had been propelled by a screw. Ericsson had previously done much, and displayed great originality of thought. The form of his propeller, although not the subject of this patent, had never yet been surpassed, and it required only the elongated pitch to make it the most efficient yet constructed. He, the lecturer, was influenced by this opinion, when recently called upon to construct the small vessel called the *Liverpool Screw*, which had been at work on the Mersey. He had taken care not to infringe any patent on the screw he adopted, and was surprised to find, on looking over the list, that these valuable plans have been overlooked. Several experiments had been made by Messrs. Brunel, Claxton and Guppy at Bristol, under the superintendance of the latter, upon various forms of screw in the Archimedes. In these some curious facts were observed, and it was then suggested that it was possible to propel a vessel faster by the screw, than the screw itself would have gone, had it worked in a solid medium. He at first conceived that there was an error in the calculations, but subsequent observation induced him to believe it possible to obtain such a result, and that all vessels having the screw in the dead wood, or run, have a tendency to go faster than the theoretical calculation would lead us to expect—though if this tendency were increased, it would be at a loss of power. He accounted for it by the manner in which water fell into the vacancy left as the vessel passed onward. A similar operation might be observed in watching the eddy formed by the pier of a bridge, in which case the body was stationary, and the water moved, but their relative positions were the same in both. The conclusion, therefore, was, that though the relative effect between the screw and the vessel appeared to be favorable, yet that being obtained at a great sacrifice of power, such a result might arise from defects in the form of the vessel, and was, therefore, no good indication, and that the utmost efficiency would be obtained, when the speed of the screw was from one-fifteenth to one-twentieth part greater than that of the vessel. The lecturer then noticed some of the most remarkable screw vessels that had yet appeared, and the forms of the propellers employed, and considered the difficulties that opposed the general introduction of the screw, and showed that some of the objections to it were groundless. He showed, by diagrams of two vessels of equal size,

that where paddle wheel vessels could not easily have any beams over the engine room, on the plane of the lower deck, as the engine, etc., rose to the deck above, beams might be introduced in screw vessels at that point, not only greatly strengthening the vessel where she most wanted it, but admiting of a clear range of saloons, or cabins, fore and aft, with little or no interruption.

A short, interesting discussion took place, in the course of which the chairman ably and convincingly replied to the questions propounded, on the supposed lateral pressure of the screw.—*Mining Journal.*

COST OF TRANSPORTATION ON RAILROADS.

The cost of transportation on railways is the most important engineering topic at this time before the public. Hence every circumstance in any way elucidating the subject, even in a very small degree, is worthy of attention. In 1843, the freight on the Western railroad was equal to 60,350 tons carried 156 miles, or 9,414,621 tons carried one mile, the average load being $47\frac{5}{8}$ tons per train, *nett.* The passenger trains ran 216,139 miles, the merchandize trains 197,603 miles, miscellaneous trains 27,866, in all 441,608 miles. The total cost was $283,826 43, or $64\frac{1}{4}$ cents per mile run. If we assume the cost of all the trains to be equal, this would give 1·34 cents per ton per mile with trains averaging about half the power of the engines, and overcoming grades of 84 feet per mile, at an average velocity of 15 miles per hour. With a speed of 8 miles per hour, and grades of from 35 to 40 feet per mile, twice the load would be taken without any additional expense than the loading, unloading and wear of cars, say 3 mills per ton per mile, making the total cost 96 mills per ton*per mile, exclusive of renewal of track. If the engine can take 150 tons, all expenses including repairs and renewals would not exceed one cent per ton per mile, which is about the estimate of the Baltimore and Ohio railroad company as given in our last number. As the cost of the freight trains is not given separately, we have assumed the cost to be equal.

The receipts for merchandize were $275,606 19, or $4 57 per ton, or $·0299, say 3 cents per ton per mile, and this "exceeded the entire expense of conducting the business of the road." The total amount paid for transportation on the Erie canal is estimated at from $4\frac{1}{2}$ to 5 millions of dollars for carrying nearly 400,000 tons a distance of 363 miles. This gives very nearly 3 cents per ton (of 2000 pounds) per mile. Again, the statement of the Delaware and Hudson canal company gave $2\frac{3}{4}$ cents per ton per mile as the amount received in 1843. Could the Western railroad run with full trains at a low rate of speed, and be sure of 200,000 tons of freight per annum, it does appear to us that it could carry quite as cheaply as any canal in the State of New York, supposing both to yield not less than 8 per cent. on their capital. Where dividends are passed by, as on the public, and, we are sorry to say, on some of the private works of Pennsylvania, they can of course carry more cheaply than those who do not choose "to work for nothing and find themselves."

SPARK ARRESTER.

We have in our office a very neat model of Messrs. French and Baird's patent "Spark Arrester." In the accompanying wood cut, (fig. 1,) is a vertical section through the axis, in which P is the smoke-pipe, from which the steam and the sparks pass through the "volutes" *v*, (figs. 1 and 2) into the chamber C, in the manner represented by the arrows. The centrifugal force generated by the "volutes," forces the sparks against the outer side of the chamber C, in which are numerous openings *o*, through which they fall down between the smoke-pipe and the outer casing. The steam escapes through the perforated plates *d*, which, from their arrangement present a very large surface for that object. The peculiarities of this arrangement are the application of the centrifugal force as above described, and the mode of increasing the surface of the wire-cloth, or perforated sheets of metal, without increasing the diameter of the pipe, by means of joining the rings at their upper and lower edges alternately, as seen in fig. 1, *d*.

Fig. 1.

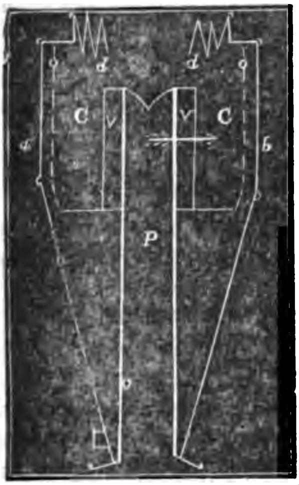


Fig. 2.

It has been in use for some time on the Georgia, Philadelphia, Germantown and Norristown, Wilmington and Baltimore, Lexington and Ohio railways, and we have seen flattering testimonials from the superintendants of all these works. The very best workmanship is indispensable; and experience has shown that certain parts require the material to be of peculiar strength and quality. When in perfect order, it has been stated to us, that, in running in the night, there is scarcely ever a spark to be seen.

The cut gives only a general idea of the "modus operandi," and numerous views and sections would be necessary to give a working plan. Messrs. French and Baird are established in Philadelphia.

RAILWAY COMMUNICATION THROUGH FRANCE.

We find in the April number of the "London Polytecnic Magazine and Journal of Science," the following article in relation to railways in France, by William Bridges.

On the 27th of December, 1841, after two years of legislative talk in the French chambers, in the course of which, sometimes the principle of leaving everything to private enterprize, sometimes the necessity of government con-

tral and supervision, sometimes the advantages of both methods was insisted on, discussed and negatived, the speech of the French king led France to expect that something would finally be done to put France, as respects railway communication, on a level with the rest of Europe. And it was full time; Belgium had already completed 80 leagues; Germany 180; England 1400 miles; France nothing. And even in April, 1842, it is stated in part IV of the commercial tariffs and regulations, presented to the British parliament, that French railroad communication embraced a very bad line from St. Etienne to Lyons, one from Paris to St. Germain, and two from Paris to Versailles. In the royal speech referred to, several important lines were announced as under consideration; among others, a line connecting Paris with Lille and Calais. It was fairly anticipated that such a line, forming a connecting link not only between Paris and London, but also between England and Belgium by way of Lille, and by means of the Belgian railways, with the Rhine, would be most valuable to English interests; while another proposed to Lyons would facilitate the overland passage to the east, as this one to Berlin and the north of Europe.

A few months after the announcement by the king of the intention on the part of government to bring in a measure for the encouragement of railway undertakings, a bill was submitted, and after some discussion became law on the 11th of June, 1842. By this law it was resolved to establish a national system of railways, to unite France with Belgium, England, Germany, the Mediterranean and Spain; and to give a stimulus to internal traffic. The mode proposed to give effect to these objects was one unsuitable, perhaps, to the English commercial spirit, but rendered absolutely necessary in France, from the difficulties which had been experienced, and the fearful jobbing which had taken place in the prosecution of the few private railway speculations which had been already entered into. The French government, seeing that hitherto a few great millionaires had engrossed every undertaking of this character, undertook now to provide the land, and execute all the earth works, tunnels, bridges, etc.; the portion left to private enterprize being less precarious, extending only to the laying on of the ballast, the formation of the permanent way, with the supply of locomotive power, carriages and *material* for working. The valuation of all lands for which compensation was required was to be left to a jury; a most wise regulation, and one which this country would do well to imitate. One-third of this compensation was to be borne by the State, the remainder by the departments and parishes whose interests were affected by the line.

Under this law a very important line has been completed to Rouen, and is now in further progress towards Havre; so that we may speedily expect to be put within a twelve hours' journey to Paris. We perceive now that an extension of the line eastward is in contemplation, to the very banks of the Rhine, to connect London, Havre, Paris and Strasburg; and as the last of these cities forming the terminus of a direct line across the richest and most industrious districts of France, is also the intended point of convergence for all the national railroads of Germany, the national and international benefits of such a line can hardly be over estimated. The distance from Havre to Paris is 144 miles, from Paris to Strasburg 286 miles, almost exactly double; the aggregate length of the journey is therefore 430 miles, one *railway hour* further than from London to Edinburgh. To traverse this route under present means of intercommunication, to transport the wines and grain and innumerable herds of La Brie and the Moselle, or the produce of the growing factories of Alsace, the continental Lancashire, between and among the various towns and cities of Paris and Strasburg, Chateau

Thierry, Nancy and the valleys of the Marne and the Saverne, is a work, which, to the Englishman, accustomed to the comfort and expedition of his Great Westerns and Midland Counties, and other railway facilities, would be appalling enough, considering that the actual traffic extends to upwards of 100,000 French tons per annum, and an aggregate of 200,000 passengers via Strasburg to and from the Germanic provinces.

The country, commencing at the Strasburg end of this great "thorougfare," is the continental United States—the provinces of Zollverein, containing nearly 30,000,000 of inhabitants, and nearly 200,000 square miles of fertile territory. The high duties of that league—or rather its vexatious and unequal duties—that on cotton alone varying from 3 to 120 per cent. on the value, being levied on the same principle as that upon tea in England, favoring the rich at the expense of the poorer classes, taken in conjunction with our restrictive commercial policy, have had the effect of unduly diverting capital in an agricultural country to commercial and manufacturing enterprize; the factories of Baden, now 300 in number, more than doubled in the course of seven or eight years, while the Saxon spinning establishments and stocking frames advanced more rapidly in three years towards 1840, than in thirty years previous. Seeing that England now sends 100,000 cwts. of cotton wool to this wool growing country, we may be convinced that there is something "rotten in the State of Denmark," which, perhaps, is to be corrected more by such facilitation of social intercourse as we here discuss, than by a modification of our tariffs. At the Leipsic fair, at least, we know that the market is inundated with smuggled English manufactures. A new facility to smuggling will lead to such measures of policy as will substitute honest and open national traffic for contraband dealing. It is in this manner that the healthy interchange of the agricultural products of France and Germany and the manufactures of England will alone be restored; or if it is now too late to look to the German States for a market for our cottons and calicos, let us even, if we can transport nothing else, be glad to find a ready and ever open conveyance for our machinery to supply the looms of Alsace, and the spinning establishments of Prussia.

SHIP CANAL.

Through the politeness of Col. Abert, of the bureau of topographical engineers, Washington, who will please accept our thanks, we have received several reports; and, among others, one in relation to the construction of a ship canal around the falls of St. Mary, in Michigan, which we give entire, except the map.

Report of the secretary of war, communicating an estimate of the cost of constructing a ship canal round the falls of St. Mary.

War Department, Jan. 4, 1844.

SIR: In pursuance of the resolution of the Senate passed on the 27th ult., I transmit, herewith, a report from the bureau of topographical engineers, with an estimate of the cost of connecting lakes Huron and Superior by means of a canal round the falls of St. Mary, adapted to navigation by steam vessels.

As the resolution calls for any estimates of the cost of this work in the possession of the department, the colonel of the corps of topographical engineers has given the plan and estimate of Mr. Almy, made in 1837, for the description of canal therein contemplated. But, deeming the resolution to look to a canal of larger dimensions, he has added his own plan and estimate

or a canal "adapted to navigation by steam vessels," based on the best information which he could obtain in relation to the subject.

Very respectfully, your obedient servant,

J. M. PORTER.

Hon. W. P. MANGUM, *President of the Senate.*

Bureau of Topographical Engineers.
Washington. Jan. 3, 1844.

SIR: In obedience to your direction, I have the honor to submit an estimate for a canal, "connecting lake Huron and lake Superior, adapted to navigation by steam vessels," called for by a resolution of the Senate of the 27th instant.

As there has never been a survey of that locality for such a purpose by this office, I am without those elements for an estimate upon which the office usually relies.

In the absence of such information, resort has been had to a survey made by Mr. J. Almy, in 1837. Mr. Almy was an engineer in the employ of the State of Michigan. Also, in anticipation that information of the kind now called for would probably be required during the present session, a letter was addressed to Capt. Johnston, at Fort Brady, in July last, proposing certain queries having reference to this canal, which he was desired to have investigated and answered. His answer of last September is hereto annexed, together with the information asked for, which was collected with much care by Lieut. Handy, of the 5th infantry.

This information, together with the survey of Mr. Almy, will enable me to submit an estimate upon which reliance may be placed.

Mr. Almy's survey, report and estimate are hereto annexed. His estimate amounts to $112,544, which would probably be sufficient for the construction of a canal of the kind and dimensions contemplated in his report.

But the resolution of the Senate contemplates a canal "adapted to navigation by steam vessels." A canal for such a purpose involves considerations that will much enhance the cost beyond the estimate of Mr. Almy. The government steamer, Michigan is 167 feet long, 47 feet wide, draws 8 feet water, and is of 600 tons burden. Freight vessels of these dimensions would draw more water, as they are generally more heavily laden; and, from the best information I have been able to collect, a draught of ten feet is the least which can with safety be adopted for the largest class of lake steamers. Nor can less than two feet of water below the bottom of the boat be adopted for the canal. These dimensions give data for the size of the canal and of the locks, viz: for the canal, 100 feet wide and 12 feet deep; for the locks, 200 feet long and 50 feet wide.

The difference of level (according to the survey) between lake Superior and lake Huron is about 21 feet, which is supposed to divide into three lifts. The locks should be collected together at the lower end, in steps, without intervening basins, as exhibited in red lines upon the plan, and should be in double sets; one set for the ascending and one for the descending trade. The towing path to be three feet above the water line, and where this path is upon the embankment it should be twelve feet wide; the berm upon the opposite side to be six feet wide; the canal to be without lateral slope, but to have the same width, except as to batter of side walls, at bottom as at the water surface; the sides of the canal to be maintained or reveted with dry stone walls. The dry masonry of these walls to be three feet wide at top, and five feet wide at bottom; but where the excavation exhibits a sufficiently firm rock facing, these dimensions may be reduced. The extension of the

work into lake Superior will have to be about 800 feet, before a sufficient depth is obtained, and there will probably have to be some excavation under water at the lower end of the canal, although the profile of Mr. Almy does not exhibit its necessity.

The total length of the canal line from water to water, exclusive of the extension of work into the lake, is about 4,400 feet, throughout a part of which an embankment will have to be raised, as exhibited in the profile. A pier to protect the entrance, of the canal, supplied with belaying posts, will have to be extended for about 800 feet into lake Superior, upon the southern side of the canal.

As lake Superior has, from various causes, a difference in its level of about four feet, it will be necessary to construct a guard lock at the junction of the canal with that lake; and, also, in order that the water may be occasionally shut off for purposes of cleaning and repairing the canal. And in consequence of variations of level in the water below the falls, the last set of locks in the series at the lower end of the canal may have in their construction to embrace the considerations due to lift and guard locks.

The prices for the excavation are taken from Mr. Almy's estimate; those for the embankment and dry walling from data in this office; those for the locks from a report of Capt. Williams for a canal to overcome the falls at Niagara, as it is not supposed that works of this kind can be done for less at St. Mary's than at Niagara.

The difference between the estimates (that of Mr. Almy and that now submitted) arises principally from differences of dimensions in the two plans, and from those considerations which belong to a canal adapted to steam navigation, and to the active trade which the canal will have to accommodate.

In works of this kind we should avoid the mistake committed at Louisville, which already, in the judgment of so many, renders the construction of a second canal at that locality necessary.

The cost of constructing this canal would be very much reduced if the U. States troops were employed upon it. A detachment of about five hundred men would accomplish the object by the usual roster details, and the difference of cost would be in the difference between the usual price of labor, and the allowance of 15 cents per day to the soldier when so employed. The employment of the army upon such works, in times of peace, is customary with all other nations, and I can see no sound objection to the adoption of the practice in our service. Such occupation is no injury to the discipline, while it preserves the bodily health and mental vigor of the men, and increases their efficiency and usefulness for their ordinary duties. These considerations are, however, not involved in the estimate.

ESTIMATE.

Guard lock at lake Superior, - - - -	$27,897 00
For cutting 18,500 cubic yards of rock under water, at $1 50 per yard,	27,750 00
For cutting 89,920 cubic yards of rock, at $1 per yard, -	89,920 00
For excavating 8,647 cubic yards of sandy loam and vegetable mould on top of the rock, at 20 cents per yard, - - -	1,729 40
Do. do. 113,607 c. yds. loam, gravel, vegetable mould, etc., at 25 cts. per yd.,	28,401 75
For embanking 15,600 cubic yards, at 12 cents per yard, -	1,872 00
For 11,555 cubic yards of dry masonry wall, at $2 per yard, -	23,110 00
For three double locks, at $66,715 each, - - - -	200,145 00
For a pier 800 feet long and 12 feet wide, - - - -	12,000 00
Contingencies, 10 per cent., - - - - -	41,282 51
Total, - - - - - -	454,107 66

Respectfully submitted by, sir, your ob't. serv't, J. J. ABERT,
Col. Corps Topographical Engineers.

HON. J. M. PORTER, *Secretary of War.*

Fort Brady, Michigan, Sept. 29, 1843.

SIR: I have the honor to enclose, herewith, answers to your queries of July 25th.

The necessary examinations have been made by Lieutenant Handy, 5th infantry.

As far as I can judge, having been over part of the ground, and from reports of others, I think he is as correct as he assumes to be; wanting, as he mentions, instruments necessary to exactness.

Permit me to add, that Lieut. Handy, besides willingly undertaking this duty, has, I think, shown both diligence and skill in the performance of it.

I am, sir, with respect, your obedient servant, A. JOHNSTON,
Capt. 5th Infantry, commanding Fort Brady.

Col. ABERT, *Chief Topographical Engineer, Washington.*

Fort Brady, Michigan, Sept. 8, 1843.

SIR: In conformity with instructions contained in your letter of July 25th, requesting information in reference to the practicability of a canal route in the vicinity of the Saut de Ste. Marie, Michigan, I have the honor to lay before you the result of my observations, having been detailed for this duty by Capt. Johnston, commanding Fort Brady. You desire to know,

1st. "What kind of soil does the projected canal pass over?"

From the upper or western extremity of the canal line to the mill race, (a distance equal to about half of its length,) the soil consists of vegetable mould, underlaid by a bed of red sandstone rock, of a very soft nature, and very thinly stratified—the strata, in many instances, not exceeding an inch in thickness. The adhesion between the strata, in many places along the canal line, is so slight that they can be easily removed with the hand. From the mill race to the lower or eastern extremity of the line, the soil consists generally of sand and loam, interspersed with boulders of granite, gneiss, etc., varying in size from two to four feet diameter. Most of these boulders are of a very good material for building, and would be serviceable in the construction of locks, etc. In many places along the line, the soil is of a very permeable nature, so much so, that upon breaking ground, the water makes rapidly.

2d. "Is the rock near the surface, or what distance from the surface, generally, in the extent of the line?"

The average depth of the rock below the surface, for the distance above mentioned, is about one foot. In some places, it is only six inches; in others, more than five feet below it—the strata dipping in a direction parallel to the line of the canal.

3d. "What is the depth of the water near the shore, at each end of the canal line, and what distance from the shore before a depth of fifteen feet is attained?"

The average depth of water at the lower end of the line, for a distance of about 60 feet from the shore, is 2½ feet, when it suddenly deepens to 6 or 8 feet. The shortest distance from the shore at which a depth of 15 feet is attained, is 52 yards. At the upper end of the line, the average depth of water is from 2½ to 4 feet. To attain a depth of 15 feet, it is necessary to go about 226 yards from the shore, in a line forming an angle of about forty degrees with the canal line. Following the direct line of the canal, it would be necessary to proceed up the river several miles before a depth of 15 feet could be attained, for the water continues at a uniform depth of about one fathom for a very considerable distance along the American side of the river, so that it is necessary to proceed out some distance in a direction at right angles with

the line of the shore to strike the channel. Upon reaching the channel, the water suddenly deepens to several fathoms; the bed of the river, at this point sloping off very abruptly, at an angle of about 30 degrees.

5th. "Is the bottom at both ends mud or rock?"

The bottom at the lower end of the line consists generally of sand, underlaid by a stratum of hard clay, with here and there a bed of sandstone rock of trifling extent.

At the upper end the bottom consists of an extended bed of sandstone rock being a continuation of the bed before described as underlaying the canal line for about half of its extent. This rock extends to a distance of several hundred feet from the shore, and is overlaid by a stratum of sand, averaging about one foot and a half in thickness.

6th. "Are there any shoal places below Fort Brady sufficient to obstruct first class lake steamers, in a passage up to near the lower end of the canal?"

About 20 miles below Fort Brady, at a widening of the river known as lake George, there is a bar of very hard clay, underlaid by a substance resembling quicksand in its properties. As this bar extends completely across the lake, all vessels navigating the river are compelled to pass over it. The depth of water upon it is very variable; sometimes exceeding nine feet, and sometimes, though rarely, not exceeding six. The average depth may be laid down at seven feet. It has frequently been crossed by the largest class of steamers at present navigating the lakes. This is the only obstruction of importance between Fort Brady and the mouth of the river, though the channel is very winding, rendering the navigation rather intricate.

It would perhaps be as well to state that the water in the St. Mary's river is much higher at some seasons than at others; and it is at present higher, by upwards of two feet, than it has been for some years past. In ascertaining the distance to which it is necessary to go from each end of the canal for a depth of fifteen feet, I have therefore made some allowance for this unusual rise of the water.

I would also remark, that owing to a want of proper instruments, my observations, respecting distances, etc., are not made with that accuracy with which I should otherwise have been enabled to make them; but I trust they will prove sufficiently accurate for all practical purposes.

I have the honor to be, very respct.'y, your ob't serv't, J. O. HANDY,

Brevet 2d Lieut. 5th Infantry.

Col. J. J. ABERT, *Chief of the Topographical Bureau.*

September, 1837.

SIR: In pursuance of my appointment from you as engineer, and in pursuance of an act of the legislature, I have the honor to transmit, herewith, the survey and estimate of the expense of constructing a ship canal around the falls of St. Mary; also, maps and profiles showing the location of the proposed line of canal, together with the depth, quantity and quality of the excavation.

Having had the honor of being one of a special committee to whom was submitted for consideration, at the last session of the legislature, the project of uniting the water of lake Superior with lake Huron by a ship canal, and having been also identified with all the subsequent proceedings as the friend and advocate of the proposed work, yet I hope that neither of these circumstances has had any influence with me in making up and presenting a more favorable report than is warranted from a careful survey and examination of the proposed line of communication.

I do not deem it necessary, before entering into a topographical description

of the country in the immediate vicinity of the proposed improvement, although it might not be out of place, neither is there required at the hands of the engineer, any speculations or statements in regard to what would be the effect on commercial operations by removing the barrier to navigation between lakes Huron and Superior.

If, however, any information on this subject should be deemed indispensable, there are sources from which, I apprehend, the most convincing and satisfactory evidence can be obtained of the importance and utility of the work in question.

By reference to the map and profile of the canal proposed, it will be perceived that no difficulties of a serious nature interpose or are to be apprehended in the event of its construction. Even that portion of the line where rock is indicated will not, owing to its peculiar quality and position, require blasting.

The total length of the proposed canal, from the deep water at the head of the falls to its termination at the foot, is 4,560 feet; and the portion which may be estimated the most difficult and expensive to excavate, embraces a distance of about 700 feet, from the head of the canal to the deep water in the river; yet, in the excavation of this part of the work, no very extraordinary expense will be involved.

As the project under contemplation comprehends a ship canal, it becomes necessary to define the capacity and dimensions and proportions of both canal and locks, as I believe will accommodate the larger class of sail vessels now used on any of our lakes, and for whose accommodation and use I make no doubt this work was originally designed and projected. I would, however, remark that the only part of the work where the expense would be increased by constructing the same to accommodate the largest class of steamboats, will consist in the increased magnitude of the locks, which, on investigation, will be found no small item.

The dimensions of the canal and locks, and upon which the dimensions have been based, are as follows: all that portion of the line where the profile indicates rock, I propose to execute by a cut affording a width of 75 feet on the surface of the water, with 10 feet depth, giving the side a slope corresponding to a bottom of 50 feet. The residue of the canal, not occupied by the locks, will have a width on the surface of the water of 100 feet.

To the locks I propose to give the following dimensions and proportions, viz: 100 feet in the clear for length, and 32 feet for width; and as the whole amount of fall to be overcome by lockage is 18 feet, I have deemed it prudent, on the ground of avoiding great hydraulic pressure on the side walls and gates, to divide the same into three lifts of six feet each.

In regard to the facilities afforded for the construction of such parts of the works as may require the use of stone, I would remark that nature seems to have left no room for complaint. The surface of the ground immediately on a line with the proposed work, and where it becomes necessary to locate the locks, is covered with large detached masses of granite, of sufficient magnitude for lock stone. And we shall duly appreciate the advantages and conveniences of having this material so near at hand, when we take into consideration the great expense of fitting and transporting this indispensable article, so necessary for the permanent and durable construction of such works, from quarries remote from the place where the same is required to be used.

With these remarks, I submit the following estimate of expense of constructing the said canal:

ESTIMATE.

Excavating 8,750 cubic yards of rock under water, between station No. 1, and deep water in river, (see profile) being a distance of about 700 feet, at $1 50 per yard, - -	$13,125 00
(This rock is red sandstone, lying in strata from two to four inches thick, easily separated.)	
Excavating 23,709 cubic yards of rock of the same quality as above, embracing a distance of 1,300 feet, from station No. 1 to 13. (see profile) at $1 per yard, - - -	23,709 00
Excavating 8,589 cubic yards of earth, consisting of sandy lime and muck on the top of the rocks, between stations No. 1 and 13, at 20 cents, - - - -	1,717 80
Excavating 28,802 cubic yards, consisting of loam, gravel and muck, from station No. 13 to 29, at 25 cents, - -	7,200 50
Excavating 21,442 cubic yards of excavation for locks, (quality of earth, as above,) at 25 cents, - - -	5,360 50
	$51,112 80

ESTIMATE FOR LOCKS. (See map and profile for its location.)

Lock No. 1.

1,322 yards of stone masonry, in water cement, at $5 50,	$7,271 00
68 feet of quarry stone at $8,	544 00
Gates and iron,	1,500 00
Foundation for locks, sills, etc.,	1,200 00
3000 yds. embankment, at 25 cts.,	750 00
Coping stone and incidental work,	800 00
Contingencies,	1,200 00
	$13,265 00

Lock No. 2.

1,322 c. yds. of stone masonry, in water cement, at $5 50,	$7,271 00
68 feet of quarry stone, at $8,	544 00
Gates and iron,	1,500 00
Foundation for locks, mitres, etc.,	1,200 00
3000 c. yds. embankment, at 25 cts.,	750 00
Coping stone, etc.,	800 00
Pumping and keeping lock pit free from water,	1,500 00
Contingencies,	1,350 00
	14,915 00

Lock No. 3.

1,322 c. yds. of stone masonry in water cement, at $5 50,	$7,271 00
76 ft. quarry stone, at $8 per ft.,	608 00
Gates and iron,	1,500 00
Foundation for locks, sills, etc.,	1,200 00
Coping stone, etc.,	800 00
200 yds. of stone masonry, wing walls, etc., at $5 50,	1,100 00
Estimated expense of coffer dam and pumping out pit,	1,500 00
Contingencies,	1,397 00
	15,376 00

RECAPITULATION.

Cost of rock and earth excavation,	51,112 80
Cost of lock No. 1,	13,265 00
Cost of lock No. 2,	14,915 00
Cost of lock No. 3,	15,376 00
Contingencies,	9,376 00
	104,044 80

In order to include every possible item of expense, I have thought proper to add a further estimate for a pier and guard gate at the head of the canal although I do not deem them absolutely necessary, and which are estimated as follows:

Laying down and filling 700 feet of pier, - - - - - - -	6,500 00
Guard gates, - - - - - - - - - - -	2,000 00
	8,500 00

This amount, added to the above, will make the sum total of $112,544 80. as the cost of constructing the proposed canal.

The above is respectfully submitted by your obedient servant,

J. ALMY, *Civil Engineer.*

His Excellency STEVENS T. MASON,

Governor of the State of Michigan.

True copy: A. CANFIELD, *Capt. Top. Engineers.*

RAILROAD RECEIPTS.

We find in the Journal of Commerce the following comparative statement of the receipts for four months on the Utica and Schenectady, Syracuse and Utica, and New York and Erie railroads. The result is highly satisfactory —showing, as it does, the regular and certain increase of business, and, of course, the extension of the railroad system.

NEW YORK AND ERIE RAILROAD.

The earnings on this road during the month of April, 1844, were

From freight,	$6,612 77
From milk,	2,166 87
From passengers and mail,	5,075 41
	$13,855 05
The earnings for the same period last year, since when the road has been extended seven miles, were,	8,946 62
	4,908 43

SYRACUSE AND UTICA RAILROAD.

Comparative receipts for four months.

	1843.	1844.
January,	$4,910 43	$5,169 39
February,	4,093 05	5,259 50
March,	4,203 64	7,384 83
April,	10,166 77	19,372 99
	$23,373 87	$37,186 71

UTICA AND SCHENECTADY.

January to May, 1843,	$46,108 47
do. do. 1844,	59,763 83
Gain of	$13,655 36

MISCELLANEOUS NOTICES.

Large quantities of up-freight remained at Albany early in May waiting for boats, though by the end of the month they will scarcely be half employed. The late opening of the Erie canal is becoming every year more injurious to the State and city, and the branches of Philadelphia forwarding houses are consequently very numerous here. It is scarcely necessary to say that this difficulty cannot be in any way affected by the enlargement—it is the want of boats, not of capacity of canal, which keeps these goods back, and if larger boats were used, there would of course be fewer of them. The spring trade—if free—would commence early in March; now it is delayed to the end of April, via the Erie canal, all the early freight going via Philadelphia, when its destination can be reached by that route, the additional cost of transportation being a small item on merchandize.

The legislature of N. York has at last granted permission to the people to transport freight on the railways between Albany and Buffalo during the suspension of navigation on the Erie canal, but paying canal tolls. By this ingenious arrangement the public will receive the smallest accommodation with the highest charges, and the railway companies can expect but a trifling return from the large additional capital invested, and the greatly increased incidental expenses. If the companies will only unite to give the farmers the greatest facilities, and be well prepared to get hold of as much merchandize as possible before the opening of the canal, the result can be neither distant nor doubtful.

The *Tonawanda railroad company* are about rebuilding their road. In 1837 one of our correspondents undertook to demonstrate that the construction of this road was such as to give the least possible strength with a given quantity of material. The projector, in answer, attempted to show that the effect was a maximum, and the communication was accompanied by drawings which placed the new mode—the "block" system—fairly before the readers of the *Journal.*

DR. FRANKLIN ON ENGINEERING.—*August*, 1772.

"I am glad my canal papers were agreeable to you. If any work of the kind is set on foot in America, I think it would be saving money to engage by a handsome salary, an engineer from here, who has been accustomed to such business. The many canals on foot here, under different great masters are daily raising a number of pupils in the art, some of whom may want employment hereafter; and a single mistake through inexperience, in such important works, may cost much more than the expense of salary to an ingenious young man already well acquainted with both principles and practice. This the Irish have learnt at a dear rate, in the first attempt of their great canal, and now are endeavoring to get Smeaton to come and rectify their errors. With regard to your question, whether it is best to make the Schuylkill a part of the navigation to the back country, or whether the difficulty of that river, subject to all the inconveniences of floods, ice, etc., will not be greater than the expense of digging, locks, etc., I can only say, that here they look on the constant practicability of a navigation, allowing boats to pass and repass at all times and season, without hindrance, to be a point of the greatest importance; and, therefore, they seldom, or never, use a river where it can be avoided. Locks in rivers are subject to many more accidents than those in still water canals; and the carrying away a few locks by freshets, or ice, not only creates a great expense, but interrupts business for a long time, till repairs are made, which may soon be destroyed again and thus the carrying on a course of business, by such a navigation, be discouraged, as subject to frequent interruptions; the toll, too, must be higher to pay for such repairs. Rivers are ungovernable things, especially in hilly countries; canals are quiet, and very manageable: therefore they are often carried on here by the sides of rivers, only on ground above the reach of floods, no other use being made of the rivers than to supply, occasionally, the waste of water in the canals."

Very serious riots occurred in Montreal, owing to the canal laborers taking possession of the polls. We regret these occurrences, as they in some degree throw odium on public works in general. At the same time, however, it is proper to state that they were engaged on government works, that they turned out to support the projectors of these works, and succeeded. All have been since "discharged," and—*re-engaged*, with few exceptions. They are of course ready for the next election. It is difficult to speak of such atrocious occurences in a Journal devoted to the advancement of civil engineering, though nothing can be more hostile to the cause to which our labors are devoted.

The *Louisville, Cincinnati and Charleston railroad company* state, in their report of 29th November, 1843, that in consequence of a diminution in charges, "the quantity transported within the same period has been quadrupled, and, in some instances, tenfold."

"Under the new reduced rates, bricks, lumber, wood, aad even coal and ice, with most of the articles of domestic produce, hitherto prohibited under the higher rates charged, are becoming important items on the freight lists; and promise, in the future, to greatly augment the profits on the road."

They have added to their stock "three of Baldwin and Whitney's new improved six wheel connected engines. These locomotives, thus far, have fulfilled their promise, not only in the greater power exerted, but in the facility with which they pass the curves; and the little injury, compared with engines of the smallest class, they inflict on the road. Those in possession of our company though of a weight not exceeding 11 1-2 tons, have

been found fully equal to the transportation of 1000 bales of cotton; and on an emergency, with the eight wheel platform cars composing their train, each might be made to haul from 12 to 1500 bales of cotton."

They point out also the vast advantages which would result from a connection with the Georgia railroad, realizing all that was anticipated, and far more than could have resulted from the route to Cincinnati, and that, too, with a comparatively small expenditure. They state one—to a friend of railways—distressing fact.

"The most imposing obstructions are still at our own door, in the interval between our depot on the neck, and the wharves in Charleston, and in the expense of the dray charges from one to the other, amounting, in many instances, to 40 per cent. on the railroad freight, on the entire distance from Charleston to Hamburg, and to Columbia!"

The *Baltimore and Susquehanna railroad company*, in their report of December, 1843, refer to new cars invented and patented by their machinist, Mr. J. Millholland.

"Each of these cars has six wheels, weighs in all about 8500 lbs., and will carry 12000 to 14000 lbs. of most descriptions of produce, the full load of an ordinary eight wheeled car. Their cost, averaging less than $450 each, is considerably below that of cars of equal quality with eight wheels."

"During the year, a purchase was made from the patentees, of the right to use what appears to be the most effectual invention which has yet been made, for preventing fires from the escape of sparks from the locomotives." * * "It has now been used for two years and a half, and since its adoption no instance has occurred of fire being communicated by sparks from the locomotives of the company. The cost of this purchase was $2000."

The name of the inventor is not given. Wood is the fuel used on this road. They complain of the late period at which the canals of Pennsylvania open: what would they say of the Erie canal?

"It is to be remarked that the Pittsburg trade over this route was not so great as it would otherwise have been, in consequence of the unusual length of time during which the Pennsylvania canals were closed last winter by the ice. In the year 1841, they were not closed until the 20th of December, and were opened on the 7th of March following, while in the ensuing fall they were closed on the 25th of November, 1842, and were not opened until the 7th of April last. There is good reason for believing that a considerable amount of produce and merchandize was in consequence diverted from this to other routes."

A route has been surveyed for a "*Northern Railroad*" from Concord to Lebanon, N.H., and a report made by Mr. T. J. Carter, engineer, who estimates the cost for a single track at $20,000 per mile, with heavy, rail, cars, engines, etc. The distance is 70 miles; 25·45 miles are level; 15·75 miles are on gradients of 52·80 feet per mile; the remaining distance consists of short planes of from 4 to 47 feet per mile. A good map and profile accompany and illustrate the report.

Hunt's Merchant's Magazine, for May, contains a paper, by W. Beach Lawrence, Esq., of this city, on the *Croton Aqueduct*. He regrets the departure from the plan of Major Douglass "in crossing the Harlem river and Manhattan valley, both of which alterations detract greatly from the magnificence, if not from the utility of the work," (p. 437.) Mr. Lawrence appears to have overlooked the late "dam," which a frequent contributor to our pages has denounced in no measured terms. The dam has been rebuilt, and has four times the capacity of the old dam. To the great cost of construction must be added the damages caused by its giving way, to the amount of about $100,000.

The following remarks of Mr. Lawrence apply with force to only too many of our great public works:

"Unfortunately, owing to collisions between the chief engineer and the commissioners to whom, according to the system prevalent in this country, the superintendence of the work was confided, and who, as is ordinarily the case, whether the enterprize is of a public or a private nature, were selected without reference to scientific qualifications, Major Douglass was, at an early day, obliged to discontinue his connection with the aqueduct, and his successor, educated in a wholly different school, however competent to the mechanical execution of the work, had none of the enlarged views which influenced the engineer with whom the plan originated."

The *Outlet at Black's Eddy* has at length been authorized. This work will ultimately be of importance to the coal trade of Pennsylvania with this city and the north and east generally. It has been strenuously opposed by those interested in the Schuylkill region, and with success till now.

An additional tax has been imposed to meet the liabilities of the canals of New York, to the amount of the interest of the loan authorized, 1,200,000 dollars.

Railway Extension.—The central railway, Michigan, has been extended ten miles to Gridley's station; to which place the cars now run.

Patents—Annual Report of the Commissioner.—We are indebted to C. M. Keller, Esq., of the patent office, for a copy of the report of the commissioner, to which we shall refer more particularly in our next number.

FOREIGN PERIODICALS FOR MAY.

By the Brittania, we have received the *Civil Engineer and Architects' Journal*, and the *London Polytecnic Magazine*, for May; but the number for June is so nearly in type that we have only room for a few extracts from the former.

There is, in this number of the Polytecnic Magazine, Part II of "railway communication through France," which treats of the "metallization of wood," and also a description of the "inclined railway into Liege," which will be given in our next.

Institute of Civil Engineers.—The discussion on the subject of slips in cuttings and embankments of railways was renewed, and extended to such a length as to prevent any papers from being read. Some observations were made by Sir H. T. De la Beche, the Rev. Mr. Clutterbuck, and several members, on the geological features of the slips, whether occurring naturally in cliffs, as at the back of the Isle of Wight, or in the artificial cuttings of railways. It was contended, that in both cases, the reduction of the lower and softer beds to the state of mud, by percolated water, rendered them incapable of bearing the weight of the superincumbent strata, and that the mass, when saturated, slid down by its own gravity; but that slips in railway work, were accelerated by the vibration caused by the passage of the trains. The vibration of the air from the discharge of a gun had been known to cause an avalanche; and the cases were almost analogous. More attention both to surface and bottom drainage of the slopes was much insisted upon; and it was urged, that the back drains, so close to the top of the cuttings, were prejudicial; that in the dry season the bottoms cracked, the rain found its way through, and it had been frequently noticed that the slips commenced at a few feet below the level of these drains. The dry shafts which had been sunk in the slopes of the Eastern Counties railway, by Mr. Braithwaite, with the concurrence of Sir H. T. De la Beche, were instanced as successful in rendering wet and treacherous strata comparatively dry and secure. A section was exhibited of the embankment at Hanwell, on the Great Western railway; this embankment which was of gravel, was 54 feet high; it was laid in a marshy valley traversed by the river Brent; the London clay, upon which it was laid, inclined towards the river, and at one of the numerous fissures with which the stratum abounds, a subsidence occured squeezing up at the same time on the lower side to as great an extent as the embankment sunk,

which was stated to be nearly as much in one year as the entire mass of the embankment. This subsidence was stopped by loading the foot of the slope, and thus restoring equilibrium, and it was stated to be at present quite secure. It was urged that in the earthwork of canals, where there was no vibration, the slips generally occurred in the first few months after the formation of the embankments; but that, on railways, they occurred quite as frequently after the lapse of several years. It appeared, therefore, that much was due to vibration."—[C. E. & A. Journal.]

ENGLISH PATENTS.

Railway Wheels.—This invention relates to a mode of so combining iron and steel in the manufacture of tyres for railway and other wheels, that the steel may be at those parts of the surface of the iron most liable to wear, after the steel and iron has been rolled into bars for the purposes above described. In order to carry out this invention the steel and iron are piled together, and then heated to a welding heat, after which they are passed under the hammer and formed into a bloom, and then passed between suitable rollers for forming it into bars adapted for tyres for railway and other wheels; by this means the steel is intimately combined, and is said will possess many advantages over the present mode of applying steel to the face of tyres for railway wheels; the patentee in some cases makes the pile so as to present a surface of iron, with steel underneath, the former being removed when turning up the wheel in the lathe in the construction thereof. The claim is for the mode of manufacturing tyres for railway and other wheels, by rolling them from piles of iron and steel, in such manner that the steel is at the wearing surface.

Axles for Wheels.—This invention consists of forming the axles of two parts or shafts, one solid and the other hollow, whereby greater strength, and less liability to breakage is obtained. In order to carry out this invention the patentee provides a tabular or hollow axle sufficiently long to pass through the bosses of each of the wheels when at the required distance from each other, the calibre or bore of this tube being sufficient to admit the solid axle passing through it, which axle consists of a solid shaft having bearings turned at each end, to fit the steps or journals in the frame side of the carriage. The wheels are firmly fixed upon the ends of the hollow axle by means of keys; the solid axle is then passed through the tabular or hollow one, and fixed therein in like manner, by means of keys. When the bearings are within the wheels it will be found necessary in forming the journals to weld two collars upon the hollow axle, so as to obtain greater strength. The claim is for the construction of axles, by combining together solid and hollow shafts one within the other, as described.—[C. E. & A. Jour.]

Separation of Metals.—The inventor takes copper, in which silver is in combination, and melts it in the usual manner; he then pours into an iron vessel containing lead melted to a red heat, or nearly so, and thereby mixes the argentiferous copper with the lead in proportion to the quantity of silver in combination. After the mixture it will be found that the copper with a portion of silver and lead will, as the mixture cools, rise to the surface, which may afterwards be taken off with a pair of tongs, or other mechanical contrivance; for instance, a perforated plate somewhat less in diameter than the size of the iron vessel in which the compounds are, is placed in the vessel, and near the bottom thereof, so that as the metals are melted it will be found that the copper, with a portion of silver, will rise through the perforations in the plate, and may be lifted out of the vessel together with the plate, which plate is provided with one or more handles for that purpose. The copper with such portion of silver as it may yet contain is then broken into small pieces, and separated by the process of "elequation," which is as follows: the pieces of copper thus obtained, together with a quantity of charcoal, are then put into a retort, or retorts, constructed with an opening at one end, through which the metals ("videlicet" the silver and lead contained in such pieces of copper) flow when in a state of fusion. The retorts, which are fixed in the furnace in a sloping position and closed, so as to exclude all air, are then heated to such a degree as to melt the silver and lead, but not the copper, which former are allowed to pass off through the opening at the lower end of the retort into a suitable vessel, leaving the copper almost free from the silver and lead, which two metals are to be afterwards separated by the ordinary process of cupellation.—[Ibid.]

Ellis' Improved Turn Table.—The objection to placing turn tables of the ordinary construction on the main line of a railway, is, that by the nature of their construction, they are rapidly destroyed, by the frequent passage of heavy trains over them, besides the injury done to the carriages, and the upleasant motion and noise. Mr. Ellis has constructed a turn table, which, when not in use, rests firmly on the curb, and thus allows the train to pass rapidly over it without injury. The iron pintle of the table on which it turns being kept well oiled, works with a loose collar round it in a vertical iron case; which case is supported and kept in its central position by two

cross arms of cast iron, at right angles to each other, and attached to the curb. The lower end of the pintle passes through the bottom of the case, below which is a stirrup attached to a cross lever passing at one end through a chase in the circular masonry, or brickwork, supporting the table; attached to the external end of the long lever, is a second lever, working in a vertical direction, and connected with a third, or handle lever, by whidh the table is put in motion or fixed, as required.—[C. E. & A. Jour.]

The "Civil Engineers' Journal," April 1st, gives a rather discouraging account of the "Great Britain," nicknamed, with some show of reason, the "Great Postponed." It appears that the admiralty has engaged the services of Mr. Brunel, to report on screws, and we hope another year will not elapse without enabling us to form a tolerably correct idea of the comparative merits of the different screws, propellers, etc., now in use. We make the following extracts:

TUBES OF LOCOMOTIVE ENGINES.

Investigation to determine the diameter of the tubes of a locomotive engine boiler to produce a maximum effect.

In treating this subject it appears rational to suppose that the effect of the hot air in passing through the tubes is directly in proportion to the extent of surface in contact therewith, and as the time of contact conjointly: that is, denoting the number of tubes by n, their diameter by d, their aggregate surface by s, their united area by a, and the time of contact by t, supposing the length of the tubes constant, we shall have the following postulates:

$$t : a$$

$$a : n\ d^2 \qquad \text{A.}$$

$$\therefore\ t : n\ d^2 \qquad \text{B.}$$

$$s : n\ d \qquad \text{C.}$$

$$\therefore\ ts : n^2\ d^3 \text{ a maximum} \qquad \text{D.}$$

Table of the comparative evaporating power of three different methods of tubing:

Number of tubes,	- -	103	78	45
Internal diameter of tubes,	inches	$1\frac{5}{8}$	2	3
Distance between centres,	"	$2\frac{3}{8}$	3	4
Interval in tube plate,	"	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$
Total circumference of tubes	"	525·82	490·09	424·05
Total sectional area of tubes	"	213·61	245·04	318·08
Product of circumference and area,		112,320	120,091	134,881

Comparison.

A : C : : 100 : 120

B : C : : 100 : 112

It appears from the above, that the boiler which is tubed in the theoretic proportion is from 12 to 20 per cent. superior to the others.

Mr. Buck concludes that with "the preceding theoretic ratio," "the area of the tubes will rather exceed the half of the space."

CONTENTS:

AMERICAN

RAILROAD JOURNAL,

AND

MECHANICS' MAGAZINE.

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REMARKS ON THE PROFESSION

In this number we devote a little space to some remarks on the present state and prospects of the profession. Some years since we entered into this question at length, and ascribed the failure of many works to the fact that they were mere political jobs, projected by persons whose education, habits and pursuits rendered them incapable of forming any idea of the grand outline of the most efficient work to accomplish the objects aimed at, and who very naturally selected kindred spirits to execute their crude designs. Whether we then ascribed too much to this cause, and whether all the canals and railways of this country would have been as much better executed by private enterprize, as we then argued, is left to the judgment of the intelligent and candid reader.

The importance of extending the sphere of usefulness of the profession, has been repeatedly alluded to by ourselves, and correspondents, and unless this be done, a large portion of those who still cling to the hope of employment cannot too soon give up all idea of engineering as a means of support. The works we more especially allude to are roads, bridges, docks, dams and the *general* arrangement of the buildings and power of large manufacturing establishments. Still with every exertion, time will be required, and some years must elapse before the community will discover that the advice and assistance of an experienced engineer may be useful to them in other works than canals and railways. Indeed some of our railways even are entrusted to persons suddenly taken from other pursuits, and the repairs of superstructure, bridges, engines, etc., are left to the discretion of the subordinate hands. Such persons are unable to enter into the details which form the amount of annual expenses, and, though quite competent to strike the balance of profit and loss, are unable to show where the main difficulties lie, far less to suggest any mode of remedying the evil. Without going so far as to attribute the failure of some works to this cause, we feel confident that we may safely ascribe to it the smallness of some dividends, in part at least.

We believe also that the higher walks of the profession have been neglected. The engineer has only too often to execute the designs of some

board, without a voice in the general plan; and it is hard to say whether the interests of the stockholders or of the profession suffer most from this cause. It must have struck all familiar with the general mode of proceeding in England, that the opinion of the engineer of the work is either closely adhered to, or at least forms the basis of discression among the directors; in many instances the opinions of numerous other engineers are taken also, not merely with reference to some mechanical detail, but as to location and general plan of the work. Now it is very easy to make preliminary surveys and reports in which all appears very smooth until submitted to the stern tests of construction and active operation. Then is seen by all with what degree of judgment the work has been adapted to its objects, both as regards the general plan and mechanical details. Then the cost, capabilities and income necessarily indicate the degree of judgment evinced in projection and execution, and that which, when the first line was traced, was a mystery to all or nearly all, becomes notorious to the casual observer. But the highest aim of the engineer is to determine, *a priori*, within reasonable limits, what *the effect* of any projected undertaking will be, and to take measures accordingly. This, however, requires something more than the use of the level and *goniometer*. It requires a thorough acquaintance with the wants of the community, as far as they are likely to be affected by the contemplated undertaking, as well as a knowledge of the various engineering means by which these wants may be best satisfied. Such information is obtained with no little labor, and to sift the mass of evidence in all such investigations, and to lay down the "projet" of the work by which these new facilities can be afforded with the least outlay, and in the best manner, is a problem to be mastered only by the union of character and liberal acquirements with the mechanical skill which forms the basis of the profession, and which is regarded by only too many as the sole requisite.

For example, suppose the enlargement of the Erie canal, the construction of the Chenango, Black river and Genessee valley canals had been submitted to such men as Brunel, Rennie, Stephenson, etc., does any one doubt that they would have condemned them? We name foreign engineers for obvious reasons, and not because we are without men whose verdict would have been equally just and decided. Indeed it is not long since the failure of the Reading railway and of the canals of Canada were predicted by two of our contributors, who went into elaborate investigations in support of their views, with what reason time will very soon show. But what we desire is to see these thorough examinations gone into before the work is commenced —nay, more, before the general plan of operations has been decided on. If this be done, we shall meet with no failures, though all that was anticipated may not be realized.

But, as already remarked, this can only be done by men of enlarged views who can take in at once the nature and extent of the engineering accommodation required, and the probability of these accommodations yielding an income sufficient to warrant their being carried into execution. And this is

not all: when the result is not favorable in the opinion of the engineer, he must report decidedly against it. Unless this be done, the profession must suffer; for, in that case, the highest engineering considerations are thrown on the directors and stockholders, who, though the proper judges of the various plans submitted, are by no means the most suitable persons to project original designs. Yet the leading features of the State works of New York were left to commissioners, men appointed with reference to their politics, and the taxes levied to meet the debts of the canals attest their capacity, in one way at least, that of running up a large debt in a very short time.

It is, however, of little consequence that the engineers have an influence in these questions, if they know nothing beyond the field work, and we have heard experienced and educated engineers complain that the younger members of the profession, who were well versed in the practice, did so little to acquire that information which is indispensable to every one who aspires to succeed in the execution of great works—we do not mean the mere expenditure of large sums. In looking over the pages of this *Journal* and that of the Franklin Institute, for the last ten years, we find a large portion of the contributions from the same writers; and although we are far from intimating that all who can contribute have done so, it must still be allowed that these Journals give some tolerable idea of the practical, scientific and even literary attainments of the profession in the United States. The objects attained by the meetings of the Institute of Civil Engineers in London must be reached here by other means, which have been well pointed out by Mr. Latrobe in the *Journal.* We are even inclined to think that the plan there proposed, that of each and every member contributing his mite to some Journal taken by all, promises more important results than could be expected from any society in so extensive a country as this.

Impressed with these views, we beg leave to remind our readers of Mr. Latrobe's suggestion, more especially that part in which he alludes to those who, seldom writing, are averse to appearing in print because they fear their style may be inferior to the matter of their productions. Now the style—provided it be tolerably clear—is of exceedingly little importance, and we will venture to say that any striking improvement or original suggestion in any of the mechanical arts connected with engineering, will be immediately seized on and appreciated by the educated engineer, be the language ever so crude. More than this, it will be found that the most accomplished members of the profession will be the very last to regard the mere style of a contribution of a practical man on a practical subject.

In this number we conclude the explanation of the very extensive tables of excavation and embankment already published, and remain as ever desirous of making our columns the medium of conveying as much practical and definite engineering information as possible. Now it appears to us that this might be easily accomplished if engineers in different parts of the country would contribute their views on various points, not in elaborate essays, but in "Notes," as leisure or inclination may permit. This mode of com-

municating is attended with this advantage, that many minor but still important subjects which are not considered sufficient for a formal paper, may be easily treated in the familiar form of "Notes." We know that the gentleman to whom we are indebted for the "Notes on Practical Engineering," is not without hopes that others will also give their views on those points to which they have devoted particular attention, or in treating which they differ from the ordinary course.

There appears to be at this time a probability that public works will soon be extensively undertaken, and their steady continuance would be certain if engineers generally would decidedly report against all extravagant and injudicious projects which sink the money of the stockholder, ruin his confidence in the profession, and, of course, destroy the prospects of the engineer: in one word—character, united with skill, are required to give the profession anything like the standing and influence it has in England, the *results* of which the world is familiar with.

We should have remarked above that Smeaton and Telford, both *self-made* men, as well as all the first engineers in England at the present day, have written much and well. Brindley is an exception, and a most *dangerous* precedent for any man not gifted with his extraordinary natural abilities. The habit of writing leads to very close investigations, and necessarily *induces* habits of exactness and accuracy, than which nothing is more important to the engineer; and we close these remarks, which have grown upon *our* hands, with observing that, in our widely extended country, a general habit on the part of engineers of contributing papers, notes or memoranda on various appropriate topics, offers the best—certainly the surest mode of raising the standard of the profession, as well as of rendering it more useful and honorable to the country and to its members.

CANADIAN WORKS.

It appears that £300,000 of the Canadian loan, the interest of which—4 per cent.—is guaranteed by the British government, has been taken at 112. We regret exceedingly that no portion of the loan has been devoted to railways, cheaply constructed and adapted to the immediate wants of the community, instead of being nearly all laid out on canals, which *may* be required some century hence at soonest. The following extract is from a late Montreal paper. It appears that these—as we believe—most unfortunate undertakings are as fruitful of immediate suffering and disgrace as of permanent injury to the country; for the tide of emigration is not more rapidly turned by the cholera itself than by taxation. The land was taken about *two* years since!

"By letter in the *Melanges Religieux*, we see that the farmers along the line of the Beauharnois canal are all complaining of delay in receiving payment of the indemnity due to them for land taken up by the canal, as well as for damage done to their property, and even for labor performed as far back as last season. This is not right."

EXPLANATION AND ARRANGEMENT OF THE TABLES.

Tables I to XXI, with exception of tables VII, XIV and XXI, are contents for average depths, bases 15, 18, 25, 28, 30 and 34 feet for each of the side slopes ½ to 1, 1 to 1 and 1½ to 1.

Tables VII, XIV and XXI, are corrections for differences of depths for the same slopes.

Table XXII, contents of prisms with square bases.

These tables are all calculated for a length of 100 feet, the depths being supposed given in feet, and the contents are expressed in cubic yards.

The remainder of the tables, XXIII, XXIV, XXV and XXVI, are greater and lesser areas, horizontal and side distances for the side slopes ½ to 1, 1 to 1, 1½ to 1 and 2 to 1. Column first contains the inclination of the surface of the ground in degrees. The second and fourth columns, marked A and *a*, contain the greater and lesser areas A L E, E D M, (fig. 1) when E I or H is one. The sixth column, marked (A — *a*), contains the difference between the second and fourth, to be used when the degree of inclination is the same on both sides of the centre line of the road. When the inclination is not the same on both sides, the areas must be taken out separately for each side, and afterwards subtracted. The third, fifth and seventh columns are half the difference of the numbers in the preceding columns. The other columns in these tables are the greater and lesser horizontal and side distances, arranged in a similar manner to the columns of areas.

The greater areas, horizontal and side distances, are used when these dimensions rise above the centre line of an excavation, and the lesser areas, horizontal and side distances, when below the centre. In embankment the reverse obtains. The prism, of which the greater area is the base, must always be added to the content in excavation or embankment, and the prism, of which the lesser area is the base, must always be subtracted.

EXAMPLES, SHOWING THE MANNER OF USING THE TABLES.

First. Cases where the natural surface is level transversely.

Example 1. A cut, the base of which is 25 feet, side slope 1½ to 1, depth 10·5 feet throughout, is 100 feet in length, required the content.

Turn to table XVII, and opposite 10 feet, and under ·5, will be found the required content: 1585 cubic yards.

Example 2. An excavation, having the same base and side slope, is 19 feet deep at one end, 2 feet at the other, and 100 feet in length, the content is required.

The average depth (or ½ sum of the depths at the ends) is 10·5 feet, and the difference of the depths is 17.

The content for a depth of 10·5 feet is - -	**1585**	cub. yds.
And the correction for a difference of 17 feet is found in table XXI, - - - - - -	**134**	"
Hence the true content is - - - -	**1719**	"

When the length is not 100 feet, multiply the result obtained from the tables by the given length, and divide by 100 for the true content.

Example 3. A cut, the base of which is 15 feet, side slope $\frac{1}{2}$ to 1, and length 300 feet, is 10 feet deep throughout, required the content.

The content for a depth of 10 feet and length 100 feet is found by table I to be 741 cubic yards.

$$\text{Hence, } \frac{741 \times 300}{100} = 2223 \text{ cubic yards.}$$

It will be observed that when the excavation or embankment runs to nothing at one end, the same method is applicable; $\frac{1}{2}$ the depth at the other end being the average, and the depth itself being the difference of depths.

Example 4. An embankment is 25 feet wide on top, has a side slope of $1\frac{1}{2}$ to 1, is 6 feet deep at one end, and runs out in a length of 30 feet, required the content.

The content for the average depth, 3 feet, is, by table XVII,	328	c. yds.
The correction for difference of 6 feet, is, by table XXI,	17	"
The content for a length of 100 feet is,	345	"

$$\text{Hence, } \frac{345 \times 30}{100} = 103{\cdot}5 \text{ cubic yards.}$$

When there is excavation at one station and embankment at the succeeding one, the length of excavation will be found by multiplying the depth of excavation by the whole distance between the stations, and dividing by the sum of the depths of excavation and embankment.

Example 5. Let there be 7 feet depth of excavation at one station, and 3 feet embankment at another, 100 feet distant from the former.

$$\text{Then, } \frac{7 + 100}{7 \times 33} = 70 \text{ feet length of excavation,}$$

$$\text{and } 100 - 70 = 30 \text{ feet length of embankment.}$$

Hence the content of each can be found as in 4th example. When the base is different from that for which any of the tables are calculated, the content can be found by equation (Y), in which it will be observed that H and H′ are the sums of the depths and $\frac{1}{2\,m}$th the base. Find the number in table XXII, for prisms 100 feet in length, corresponding to square bases whose sides are $\frac{H + H'}{2}$, $H - H'$ and $\frac{B}{2\,m}$ respectively. Then from the sum of the first and $\frac{1}{12}$ the second subtract the third, and multiply the remainder by the slope (m) for the content of a length of 100 feet.

As we have already explained the mode of proceeding when the length is not 100 feet, it is unnecessary to introduce instances of uneven distances,

and in the following examples, the length of excavation and embankment must be considered always 100 feet, unless some other distance is specified.

Example 6. In an excavation the base is 14 feet, slope 1 to 1, and depths at the ends 10 and 2 feet.

Here $H = 17$, $H' = 9$, $\frac{H + H'}{2} = 13$, $H - H' = 8$, $m = 1$ and $\frac{B}{2m} = 7$.

$\frac{H + H'}{2} = 13$	corresponding number	for	table XXII,	626 cub. yds.
$H - H' = 8$	"	"	table XIV,	20 "
				646 cub. yds.
$\frac{B}{2m} = 7$,	"	"	"	181 cub. yds.
Content,	.	.	. .	465 cub. yds.

When it is only required to ascertain the whole content of an excavation or embankment, and the stations have been taken at uniform distances from each other, the labor of the calculation may be somewhat abridged by the adoption of the mode pursued in the next example.

Example 7. Let the base of an excavation be 40 feet in width, the side slopes 2 to 1, and the depths of cut at intervals of 100 feet, as stated in the left hand column of the following table; required the content of the excavation.

Depth in feet.	H + H'* in feet.	Cor. No. from table xxii c. y.	H — H' in feet.	Cor. number table xiv c. y.
0·0				
2·0	42·0	6533	2·0	1
3·6	45·6	7701	1·6	0
8·9	52·5	10208	5·3	9
12·4	61·3	13917	3·5	4
14·0	66·4	16329	1·6	1
9·0	63·0	14700	5·0	8
6·0	55·0	11204	3·0	3
4·2	50·2	9333	1·8	1
2·1	46·3	7940	2·1	1
0·0	42·1	6564	2·1	1
		4)104,429		29
		26,107		
		29		

26,136 ; now $\frac{B}{2m} = 10$ cor. No. tab. 370;

hence, $\frac{370 \times L\,(=1000)}{100} = 3700$

22426.

Hence $6725 \times m\ (= 2) = 44{,}872$ cubic yards is the total content of the excavation.

Note. Double the depth gives four times the content.

Second. *Cases where the natural surface of the ground has an inclination at right angles to the line of the road.*

EXAMPLE 8. An excavation, the base of which is 28 feet, side slope 1 to 1, and depth throughout 10 feet, has a transverse slope right and left of 12°; required the content.

First Method. Here (area $a\,l$ E — area E $d\,m$) for 12° in table XXIV is ·0473, and $\left(10+\dfrac{B}{2\,m}\right)^2 L = (24)^2\,\dfrac{100}{27} = H^2\,L$ in table XXII is 2133 cubic yards.

Consequently - - - - -	2133 c. yds.
	3740 "
multiplied by ·0473 - - - -	853 "
	149 "
	6 "
gives the correction - - - - -	100·8 c. yds.
which added to average content from table XI -	1407·0 "
makes the total content - - - - -	1507·8 c. yds.

Second Method, (by equation X). Here,

$$H^2\,(Y+y)\,\frac{L}{2}-\frac{B^2\,L}{4\,m}\ \text{equal the content.}$$

$H^2 \times L = (24)^2 \times \dfrac{100}{27}$ is found in table XXII opposite 24,	2133 c. yds.
	3740·1 "
$\frac{1}{2}\,(Y+y)$ in table XXIV is $\dfrac{2{\cdot}0946}{2} = 1{\cdot}0473$	2133·0 "
	85·3 "
	14·9 "
	·6 "
	2233·8 "
Subtract $\dfrac{B^2\,L}{4\,m}$ (table XXII) - - -	726·0 "
and we have for the true content as before	1507·8 "

EXAMPLE 9. An embankment, 25 feet wide on top, having a side slope of $1\frac{1}{2}$ to 1, is 12 feet deep at one end and 4 at the other, and has a transverse slope right and left of the centre at both ends of 12°; required the content.

First Method, (by formula N)

$$\left\{H^2 + H'^2 + (H+H')^2\right\}(A-a)\,\frac{L}{6} = \text{correction for transverse slope.}$$

$H^2 \times L = (20{\cdot}3)^2\,\dfrac{100}{27}$ = No. cor. to 20·3 in tab. XXII is	1526 c. yds.
$H'^2 \times L = (12{\cdot}3)^2\,\dfrac{100}{27}$ = " 12·3 " "	560 "
$(H+H')^2 \times L = (20{\cdot}3+12{\cdot}3)^2\,\dfrac{100}{27}$ No. cor. to 32·7 "	3960 "
	6046 "

$\frac{1}{6}$ area (A — a) for 12° in table XXV col. 6 is $\frac{\cdot 1698}{6} = \cdot 0283$, 3820 c. yds.

	1209	"
	484	"
	18	"
Therefore the correction for transverse slope is	171·1	c. yds.
Content for average depth 8 feet in table XVII,	1096·	"
Correction for difference " " XXI,	30	"
Total content,	1297·	"

We might have found the above correction for transverse slope by adding the value of equation (O) to the correction for a uniform depth $\frac{H + H'}{2} =$ 16·3.

$$(H - H')^2 (A - a) \frac{L}{12} = \frac{8^2}{12} \times \frac{100}{27} \times \cdot 1698 = 3 \text{ cubic yards.}$$

We see that in this case it would have been sufficiently accurate for all practical purposes in obtaining the correction for transverse slopes to have supposed the depth uniform throughout.

The following table shows the difference of depths answering to given values of A — a when the value of equation (O) becomes 10 cubic yards.

A — a	H — H′	A — a	H — H′	A — a	H — H′
·1	18·0	·6	7·4	1·1	5·4
·2	12·6	·7	6·8	1·2	5·2
·3	10·4	·8	6·4	1·3	5·0
·4	9·0	·9	6·0	1·4	4·8
·5	8·1	1·0	5·7	1·5	4·6

By comparing the values of A — a above given with the difference of areas as exhibited in tables XXIII, XXIV, XXV and XXVI, it will be seen that there will but few cases occur where equation (O) need be considered.

Second Method, by equation (V),

$$\left\{ H^2 + H'^2 + (H + H')^2 \right\} (Y + y) \frac{L}{12} - \frac{B^2 L}{4m} = \text{content,}$$

$\left\{ H + H'^2 + (H + H')^2 \right\}$ L as before, 6046 c. yds.

	3812	"
$\frac{1}{12}$ (Y + y), (table XXV, column 12), $\frac{3 \cdot 3397}{12} = \cdot 2783$	12092	
	4232	
	484	
	18	
	1683·	"
Deduct $\frac{B^2 L}{4m}$, - - - - -	366·	"
And there remains the content of embankment, the same as before.	1297·	"

Example 10. The transverse slopes and depths at the two extremities of an excavation, the base of which is 28 feet, and the side slope 1 to 1, are as represented in the following statement; required the content.

Depth at centre.	Slope to right.	Slope to left.
14 feet	$+12^\circ$	-6°
6 "	$+4^\circ$	-9°

The sign + prefixed to the right slope indicates that the ground is higher on the right of the centre, and the sign — before the left slope, shows that the natural surface falls from the centre on the left.

Examples of this kind will be solved most conveniently by equations (S) and (T). Here we have

$$\left\{ H^2 + H'^2 + (H + H')^2 \right\} (Y + y + Y' + y') \frac{L}{24} - \frac{B^2 L}{4m} = \text{content},$$

$$\text{and } (H^2 - H'^2)(Y + y - Y' - y') \frac{L}{12} = \text{correction}.$$

From table XXIV we have

Y for 12°	1·2699	and Y' for 4°	1·0752
y for 6°	·9049	y' for 9°	·8633
$Y + y$	2·1748	$Y' + y'$	1·9385
	1·9385		2·1748
	24)4·1133		12) ·2363
$\frac{1}{24}(Y + y + Y' + y') =$	·1714	$\frac{1}{12}(Y + y - Y' - y') =$	·0197

$H^2 \times L = (28)^2 \times \frac{100}{27}$, (table XXII), - - 2904 c. yds.

$H'^2 \times L = (20)^2 \times \frac{100}{27}$ " - - - 1481 "

$(H + H')^2 \times L = (48)^2 \times \frac{100}{27}$ " - - 8533 "

12918

Multiplied by $\frac{1}{24}(Y + y + Y' + y') = ·1714$, - 4171

12918
9043
129
52

And we have for content, - - - - 2214 c. yds.

$(H^2 - H'^2) L$ - - - 1423 c. yds.

7910

Multiplied by $\frac{1}{12}(Y + y - Y' - y') = ·0197$, 142
128
10

28· c. yds.

2242· "

Subtract $\frac{B^2 L}{4m} = \left(\frac{28}{2m}\right)^2 L m$ - - 726 "

And we have for the true content, - - - 1516· "

Another Method, by equations (L) and (M).

$$\left\{ H^2 + H'^2 + (H + H')^2 \right\} (A - a + A' - a) \frac{L}{12} = \text{1st correction.}$$

$$(H^2 - H'^2) \left\{ (A - a) - (A' - a) \right\} \frac{L}{6} = \text{2d correction.}$$

From table XXIV we get,

under A and opposite	12°	·1350	and under A′ and opposite	4°	·0376
" a "	6°	·0476	" a' "	9°	·0684
$A - a$	-	+ ·0874	$A' - a'$	-	— ·0308
		— ·0308			+ ·0874
	12)	+ ·0566		6)	+ ·1182
$\frac{1}{12}(A - a + A' - a')$		·0047	$\frac{1}{6}\left\{(A - a) - (A' - a')\right\}$		·0197

$\left\{ H^2 + H'^2 + (H + H')^2 \right\}$ L as before, - 12918 c. yds.

	7400	
multiplied by $\frac{1}{12}(A - a + A' - a') = \cdot 0047$	517	
	90	
gives us for the 1st correction, - -		61 c. yds.
and $(H^2 - H'^2)$ L - -	1423 c. yds.	
	7910	
multiplied by $\frac{1}{6}\left\{(A - a) - (A' - a')\right\} = \cdot 0197$	142	
	128	
	10	
gives us the 2d correction, - -		28 c. yds.
Content for average depth 10 feet (table XI), - -		1407 "
Correction for difference of depths 8 feet (table XIV), -		20 "
Total content, - - - -		1516 "

EXAMPLE 11. The base of an excavation is 18 feet wide, side slopes 1 to 1, and depth at centre 8· feet, depth at right slope 13· ft., depth at left slope 4· ft.,
" " " 21· " " " " 30· " " " 14· ft.;
required the content.

First Method, by equation (E).

Here, H = 17, H′ = 30, P = 5, p = 4 P′ = 9 and p' = 7.

Hence, $\left\{ (2H + H')(P - p) + (H + 2H')(P' - p') \right\} \frac{mL}{12} = 67$ c. yds.

Content for average depth 14·5 feet (table IX) = -	1745 "
Correction for difference of depths 13· feet (table XIV) =	52 "
Total content, - - - -	1864 "

Or by equations (F) and (G),

$(H + H')(P - p + P' - p') \frac{mL}{8}$ = 1st cor. transverse slope = 65 c. yds.

$(H - H')\left\{(P - p) - (P' - p')\right\} \frac{mL}{24}$ = 2d " " " 2 "

Total correction for transverse slope same as before, 67 "

Here we might have omitted the 2d correction for transverse slope, as it only amounted to two cubic yards.

Second Method, by equation (R).

Here, $H = 17$, $H' = 30$, $W = 22$, $w = 13$, $W' = 39$ and $w' = 23$.

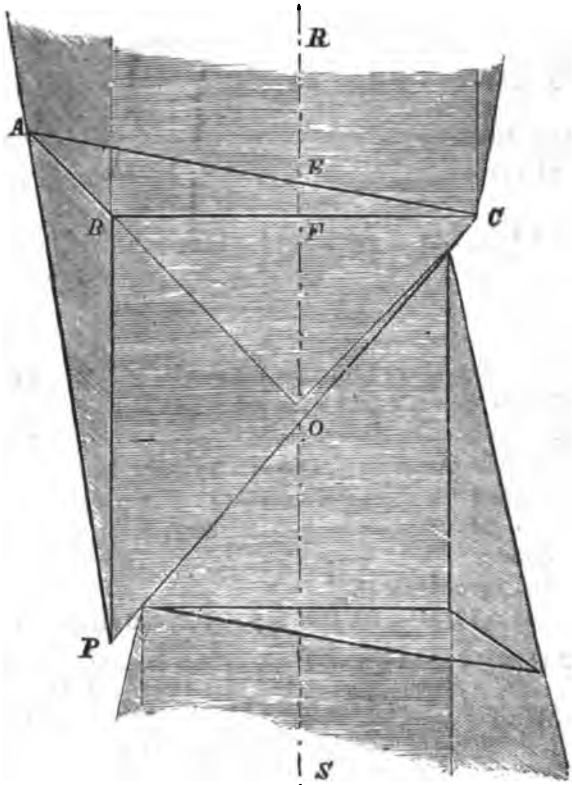
Hence, $\left\{(2H + H')(W + w) + (H + 2H')(W' + w')\right\} \frac{L}{12} = 2164$ c. y.

Deduct $\frac{B^2 L}{4 m} =$ . . . . . . 300 c. y.

And we have as before, ... 1864 c. y.

When the work changes from excavation to embankment in sloping ground, the content will be found by the method which will now be explained.

Fig. 3.



Let R S (fig 3) represent the centre line of the road, C P the line in which the plane A C P of the natural surface of the ground intersects the base of the excavation, A B C a perpendicular plane at right angles to R S passing through C, A B P will be the side slope of the excavation, B C the base and E F the depth at the centre. The content for the distance R F is found by formula ( ) as in example 10, and the content of figure A B C P is

found by formula (L). When the pyramid A B C P is of importance, the depth and transverse slope at F and the length B P must be measured on the ground, but as this may not always be convenient it will be proper to indicate a method of finding them approximately by calculation.

The transverse slope may be assumed as varying uniformly from R to S; the distance from R to O is found as in example 5; then as depth at station R is to that at F, so is length R O to F O, and B P is equal to 2 F O.

EXAMPLE 12. There is 12 feet excavation at one station and 8 feet embankment at the next, transverse slopes 12·° and 14·°, side slope 1 to 1, base 30 feet and length 100. Required the quantity of excavation and embankment, the base of embankment being 25 feet and side slope $1\frac{1}{2}$ to 1?

$$\text{Here, } 12 + 8 : 100 :: 12 : 60 = \text{R O},$$

and taking 13° as the transverse slope at O we have $\frac{B}{2} \times \tan.\ 13° = $ depth at F $= 3{\cdot}5$, then, $12 : 60 :: 3{\cdot}5 : 17{\cdot}5 = $ F O and B P $= 2 \times$ F O $= 35{\cdot}0$, formula (L), for a pyramid reduces to $H^2 \times A \times \frac{L}{3}$.

H′, A′, a and a' being each $= 0\cdot$ which is the common rule for the solid content of a pyramid.

Here, $H^2 = \left(\frac{B}{m}\right)^2 = (30)^2$, L = 35 and A from table XXIV = ·1501.

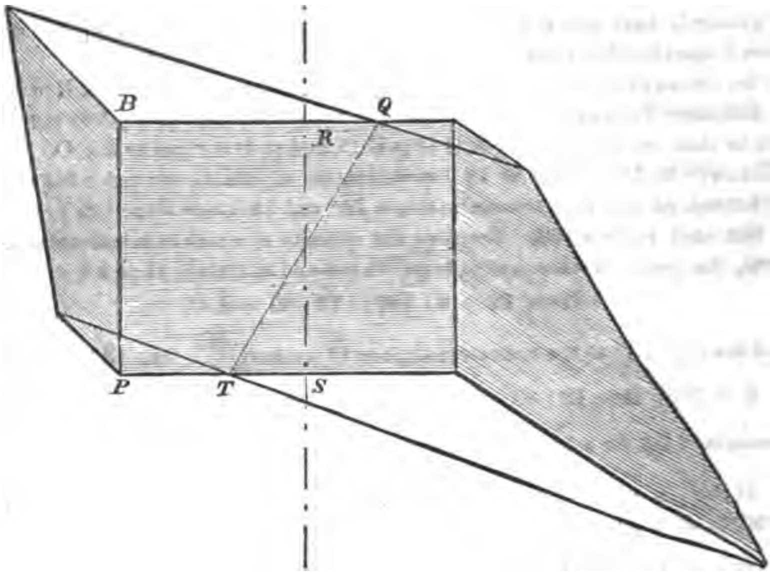
$H^2 \times \frac{100}{27} = (30)^2 \frac{100}{27}$ from table XXII, - -	3333· c. yds.
	5710
$A \times \frac{L}{3} = \frac{\cdot 1501 \times 35}{3 \times 100} = \cdot 05 \times \cdot 35 = \cdot 0175$, - -	333
	233
	17
Content of pyramid, - - - -	58·3 "
Content for length R F calculated as in example 10, -	512· "
Total excavation, - - - -	570· "

The transverse slope for the pyramid of embankment will be nearly $13\frac{1}{2}$° and the content calculated in the same way as for the pyramid of excavation is - - - - - - 44· c. yds.

And the embankment for the remainder of the distance, -	215· "
Total embankment, - - - -	259· "

When the transverse slopes at R and S (fig. 4) cut the base, so as to make one side of the roadbed in excavation and the other in embankment, the distances of these points from the centre line Q R and S T can always easily be measured on the ground, or they may readily be obtained by multiplying the natural cotangent of the transverse slope by the depth at the centre; whence the widths in excavation and in embankment are found, and the contents calculated by equations (L and M) as in example 10.

Fig. 4.



Example 13. Given at one station 2 feet cutting and transverse slope 12°, at the next 1 foot filling and transverse slope 14°, length 100 feet, *in excavation* base 30 feet, and side slope 1 to 1, and in embankment base 25 feet and side slope $1\frac{1}{2}$ to 1; required the contents?

Here a and a' being nothing, equations (L and M) become

$$\left\{ H^2 + H'^2 + (H + H')^2 \right\} (A + A') \frac{L}{12} = \text{content.}$$

$$(H^2 - H'^2)(A - A') \frac{L}{6} = \text{correction.}$$

$$H = \frac{1}{m}\left(\frac{B}{2} + 2 \times \cot. 12^\circ\right) = 15 + 9{\cdot}4 = 24{\cdot}4$$

$$H' = \frac{1}{m}\left(\frac{B}{2} - 1 \times \cot. 14^\circ\right) = 15 - 4{\cdot}0 = 11{\cdot}0$$

$\left\{ H^2 + H'^2 + (H + H')^2 \right\} \frac{L}{12}$ from table XIV,	.	608 c. yds.
		1103
$A + A' = {\cdot}1350 + {\cdot}1661$ from table XXIV,	. .	1824
		6
Content,	. . . .	183· c. yds.
$(H^2 - H'^2)(A - A') \frac{L}{6} =$ correction,	. . .	—9 "
Total excavation,	. . . . . .	174 c. yds.

For the embankment,

$$H = \frac{1}{m}\left(\frac{B}{2} - 2 \times \cot. 12^\circ\right) = \frac{12{\cdot}5 - 9{\cdot}4}{1{\cdot}5} = 2{\cdot}1$$

$$H' = \frac{1}{m}\left(\frac{B}{2} + 1 \times \cot. 14^\circ\right) = \frac{12{\cdot}5 + 4{\cdot}0}{1{\cdot}5} = 11{\cdot}0.$$

Then, $\left\{H^2 + H'^2 + (H + H')^2\right\} (A + A')\frac{L}{12}$. 72·7 c. yds.

$(H^2 - H'^2)(A - A')\frac{L}{6}$ . . . . . 3·5 "

Total embankment, ... 76·2 "

When the ground is so uneven that the transverse slope cannot be accurately taken in degrees, and it becomes necessary to take the depths at several points in the cross section, the following method will sometimes be found a convenient approximation.

To the area of the cross section of the excavation add $\frac{B^2}{4m}$ and divide by m, then, from a table of square roots, take the square root of this quantity for the depth on H, and calculate the content from table XXII as in example 6.

Or the content may be calculated by the following general rule which is to be found in any treatise on mensuration.

Multiply the sum of the end areas and four times the middle area by one-sixth of the length for the content.

MEMORANDUM—CUBICAL QUANTITIES.

At the time the "Notes" on this subject were written, I had not seen the paper of Mr. E. Morris, C. E., in the Franklin Journal, in which he shows the application of the "prismoidal formula', to all cases; more especially to determining the quantities for final estimates where the ground is very difficult. This able paper well deserves the attention of the engineer; and, together with the published tables, will give all desirable assistance in the rough estimates from preliminary surveys, as well as in the careful and often tedious calculations for putting the work under contract.

In the paper on "Bridges," there is a typographical error, (p. 9,) I wish to correct. For "screwed in" read covered in. Also at the close of Notes on "Wharves," for "filling" read piling.

New York, May, 1844. W. R. C.

NEW ROTARY ENGINE.

The inventor, Mr. Peter Borrie, says:

"I am aware that many patents have been taken out for revolving engines, and have successively failed, owing chiefly to defects in their construction; these failures have prejudiced the public mind against all engines on that principle, but from the long experience I have had (both practically and theoretically) with steam engines of every description, I flatter myself that I have entirely remedied the defects common to revolving engines; and from the lightness, compactness, small amount of wear and tear, and greater economy of fuel in my engine, I have no doubt that it will surpass all others hitherto in use." * *

"Among the advantages which render this improved steam engine so peculiarly well adapted for locomotive and marine purposes, may be mentioned the following, viz: small cost of construction, great economy of fuel, the space occupied by it is very little in pro-

portion to its power, and also its comparative lightness, the weight of the engine being only about 2 cwt., per horse power, and that of the boilers only about 2 3-4 cwt., per horse power, so that the whole weight will only be about one-half of the lightest engine hitherto constructed."

He then goes into an elaborate calculation of the power of this as compared with the ordinary engine, and concludes with the following startling announcement:

"Consequently only about one-third of the fuel would be required for the revolving engine as would be required for a common reciprocating condensing engine of the same power."

The general plan of the engine appears to us exceedingly ingenious, and likely to be effective. The patentee truly observes, "that the principle of expansion is carried out to its fullest extent, without the aid of expansion valves and gear." But the best reciprocating engines give us two-thirds of the total power of the steam at the "working point;" and we do not very clearly see how any engine can give three times as much power as those which only lose one-third of the whole. An efficient and simple rotary engine would, however, be of such vast importance to railways, by simplifying the machinery, as well as by enabling us to obtain the adhesion of any number of wheels, that we regard with interest every attempt to effect so desirable an object. We hope to hear soon something more of this revolving engine, and shall be happy to lay before our readers a full description and illustrations as soon as we learn that it has stood the test of experiment.

We copy from the "Civil Engineer," for May, the following admirable review of a letter on "Railway Administration." We should be pleased to see the letter itself, but this is more than doubtful, and indeed we regret it the less as the subject has been so well handled by the editor of that leading Journal of the profession. It was our intention to have omitted some passages uninteresting to the American reader, but we find them so few that we give the article entire. It furnishes matter for deep and serious reflection, and incidentally though very ably illustrates some points we endeavored to establish in our "Remarks on the Profession." We allude to our views with regard to general information, and the necessity of a high moral tone in all engineers entrusted in any way with the projection of works. The railway cause generally is well sustained, and last though not least to us, the creation of a railway press, and its powerful effects on the extension of public works are forcibly dwelt on. We trust we shall be pardoned for observing that we were the first to take the field under the railway banner, and though occasionally hard pressed during the last few years, we still continue to aid—to the best of our ability—the development and extension of an improvement—we may say an invention—second to few in the bearing it is likely to have in the welfare and advancement of the human family.

RAILWAY ADMINISTRATION.

"We have seldom seen a more masterly exposition on the subject of railways than is to be found in this brief pamphlet; if, therefore, we dissent from its reasonings and the remedies it proposes, it is because we draw dif-

ferent conclusions from the same premises, and regard premises upon which our author has not argued. At a time when rant and cant are so prevalent with regard to railways, and a pretext is earnestly sought to hunt them down, it is matter of great consolation to find an advocate so staunch come forward to defend them, one earnest to do them due justice, at the same time too impartial to defend their errors. Those, however, who have deeply studied the subject, and been intimately connected with them as our author has been, know that railway bodies have been much more sinned against than sinning, and will feel cautious in what way they interfere with an institution which has shown and possesses such elements of good. The railway system of England is both a moral and physical phenomenon of the age. A connected chain of public ways extending over 1800 miles, and in the construction of which 60 millions sterling have been embarked, the largest sum ever yet applied in any country in bulk to any other purpose than that of war, naturally excites attention to the colossal magnitude of the enterprize, but the moral features are still more deeply interesting. Not only has this vast sum been raised by private means, and expended under private direction, but difficulties of the most serious character have had to be contended with. At every step experience had to be acquired, invention exerted to overcome difficulties and establish new precedents, the immense amount of money required and expended, enhanced the cost of procuring it, and the price of every kind of labor and material. No colony, no new political institution, was ever formed with such difficulties and such success as the railway system; financiers, engineers and contractors had to be created, while, as we have said, the very vastness of the works have enhanced the cost of their execution. It is well, at the present time, and with our present experience, to turn round and say the railways could have been executed for less. It is true, if, as our author says, there had been no parliamentary contests, no law, no extravagant landed compensation, that much might have been saved, but we are not quite so sure as he is that the future lines to be executed will cost only the present moderate rate, and we deny, therefore, the propriety of measuring things by the present standard. At this time money is abundant and interest low, so is the price of labor and materials, and as many contractors have been ruined, and none have too much work, a line can be let at a very low price. Prices are however rising, and will rise; labor will cost more, timber will get up, iron double in price, to say nothing of a crisis by and bye, and the serious consequences of depression in the money market, which it is in the nature of events to bring about from time to time. We would not have contractors or engineers blind to these facts, for it was to such facts that many difficulties were owing at a previous period. The much vilified estimates of Stephenson, Brunel, Rastrick, Braithwaite, etc., were founded upon works actually executed, but, in the interval, a most serious difference in prices was created by the number of contracts in the field. While, however, we expect prices to rise as a matter of course, we do not anticipate the serious excesses of the old system, because many of the difficulties have been overcome. In the infancy of the railway system, as the development of traffic was not foreseen, so neither was the cost of stations duly provided for, then it must be remembered that in those days contractors were not used to works so gigantic, and were not so competent to undertake them. Now, the weight of locomotives is ascertained, and the rails will not have to be increased in weight 50 per cent. above the estimate, as was the case previously in consequence of the experience gained in the course of the working. Now many and economical arrangements are well known, people are not afraid to lay down timber bridges, as to which formerly much prejudice prevailed.

"We say that this experience, now so advantageous, had then to be gained and to be bought at every step, and that the old system instead of being chargeable with blame, is deserving of the highest degree of praise and admiration. Few know the burden which weighed on the minds of railway managers in those days, and rarely have exertions so great been made, and received so little appreciation. Our author graphically describes the difficulties of the panic.

"'Still worse was the condition of some other lines two years later. The commercial embarrassments that weighed so heavily upon the country bent them to the ground. The proprietors were totally unable to answer the calls upon them. No credit could be given, no money could be obtained. Contractors failed, works were stoped, loans were raised at usurious interest, capital was provided at a sacrifice of one-third of its amount. Whatever censure boards of directors deserved in other matters, at this time they stood forward manfully to face the storm. Many of them supplied large sums from their individual resources, and pledged their credit to a frightful extent. They risked ruin for the benefit of their fellow proprietors, which they never would have hazarded for their own. Few know the perilous state of some of these now flourishing concerns, or of the anxious days and sleepless nights of those who had to provide the sinews of war, to uphold a sinking credit and ward off impending bankruptcy and ruin.'

"We disagree with him, however, as to railway directors pushing on the works at any cost, *because* they were deeply imbued with the gambling spirit of the day. They pushed on the works as a matter of financial necessity, to which they were in the strongest degree urged by their proprietors. To the bulk of the then holders on the realization of a traffic and a dividend depended the tenure of their property, often whether they were to be rich men or beggars. When the panic came, the resources of many became inadequate to meet the heavy calls; they had to borrow or to hold on by any means. To go into the market and sell was ruin, to hold was their only chance, until the opening of some portions of the line made their shares a better security, or until the subscription of two-thirds of the capital enabled the companies to postpone the calls, and raise money on debentures. Any sacrifice of capital to gain time was preferable to throwing shares on the market, where scarcely any description of property was at par, while the perils of forfeiting everything by non-compliance with the act of parliament made shares without a traffic totally unavailable as a security for raising money. When all these circumstances are taken into consideration, railway managers will not be censured for excesses of estimates, which circumstances alone produced.

"The evils produced by the legislature the pamphlet before us well shows, it particularly dwells on the legalized extortions of land owners, and the prohibitions of level crossing of common roads, which, of course, it proposes to remedy.

"We have now, therefore, to consider the present state of the railway interest. We have so many hundred miles of railway, costing so many millions, and as a new institution has arisen, new public wants have been created, first and foremost of which is cheap travelling. In a national point of view, there can be no question upon this subject; cheap travelling is in the highest degree desirable: how is it to be obtained? Every one has his remedy; and the legislature is called upon by many well meaning individuals to cut the Gordian knot, and to buy up the whole of the railways; others, among whom our author is one, propose modifications of this principle. For our own part, we are most free to admit, that on the leading lines of traffic

the charges for travelling are absurdly high, and the accommodation for the laboring classes totally inadequate; still we are inclined to say that it is better to let the matter alone than to legislate upon it. The mischief hitherto has been in legislating for questions of public enterprize, imposing restrictions and giving privileges, which are the fertile sources of mischief, and we anticipate little good therefore from any legislative remedy, the most efficient in such cases being, in our opinion, to legislate as little as possible, but to proceed upon the broad economical principle of leaving industry to regulate itself. Not that we doubt the right of the legislature to interfere in this specific case, or in any similar case. Apart from the question of rails and locomotives, shares and shareholders, the railway system is an institution having the same public relations as a bank, a college, a hospital, or a public house, and in which any rights of private property exist subordinate to the public objects. On the equity of the case, it must be remembered, that if railways have been allowed a maximum fare, it was on the express condition that anybody should be allowed to compete with them on their own lines. This, however, is found to be injurious to the public, and the legislature has, therefore, the equity of requiring some other equivalent security for a reasonable rate of fare. Our ground for letting the railways alone on the subject of fares is, that it is more remunerative for railway companies to charge low fares than it is to charge high fares, and that this principle is making satisfactory progress, and must and will be adopted by all companies. The following observations from a very able article in the Railway Record, will be read with interest.

"'A very large amount of manufacturing business has been created by the railway system, for the supply of railway stock, and this will be ever on the increase, not merely for England alone, but for her colonies, and for foreign lands. We are prepared to see railways rise in value, in the same proportion that canals have risen. For although it be true, that the price of making railways has been reduced very low of late, it is quite certain that, with increasing traffic, those prices will rise. When railways shall commence in the East and West Indies, in Australia and China, English capital will find so many vents, that the intense existing competition will be lessened, and assuredly the value of land will rise as our population thickens. The greater the numbers of the community the more valuable will the roads become. England will be virtually the metropolis of the continent, by means of free communication throughout all lands.

"'Nothing can defeat railway prosperity, but, at the same time, nothing can check it so much as injudicious high fares. We cannot too strongly insist on this point. The increase of expenses in railways is great in proportion to the diminution of traffic, and the increase of traffic is followed by a very slight increase of expenses on the annual amount, while the proportionate decrease is very great. People are gradually getting used to travel, the circle continually widening, and as they get used to it, it becomes a necessary of life. They can no more do without it, than they can forego their provisions. But they must be inoculated to it, and this inoculation will not take place while they are frightened by high fares. We are of opinion that it would be a wise thing for railway companies to establish some rule in lowering their fares in proportion to the increase of their passengers. It is the largest number that will pay best, in all cases, and we apprehend that the lowest fares will also pay best, unless where the number of passengers is limited.'

"The author before us certainly does not go far enough for us in his proposed legislation, for he is content to have open third class carriages at ½d.

per mile, attached to all trains. Now we think as a matter of public health it is desirable that all trains should be covered, as in Belgium, and that sufficient distinction in comfort will always exist between the several classes of carriages. Third class carriages should be provided with seats, covered with tarpaulin, and have curtains; and second class carriages be first class carriages without the cushions. In practice this arrangement has worked well, and will work well. On short omnibus lines, however, open stand-up carriages do no harm. On all lines a step remains to be taken, which may be pursued with advantage, we mean the running of slow, cheap trains, going at the rate of some ten miles an hour. Such trains can be worked much cheaper than high speed trains, and there are large classes of the public to whom time is of less importance than money, females in particular.' All these things, however, may be safely left to experience, and experience is beginning to show that a high fare is the wrong system for extracting the greatest revenue from a railway. The cheap fare system is satisfactorily progressing, and will establish itself without legislative aid. A great many experiments are also being made as to excursions, return tickets, weekly, monthly, season and yearly subscriptions, the results of which are promulgated by the railway press to the general information. Here, too, we may observe, that it is not one of the least remarkable features of the railway system, that it has created a press, by the competition and energy of the members of which a degree of information is diffused which has been productive of the greatest benefits, and which under no central administration could exist. By the means of this agency upwards of a hundred reports of directors and engineers are yearly brought under the scrutiny of the great body of railway capitalists, while the comments of the shareholders at the meetings are recorded at a length, and with a degree of accuracy only surpassed by the reports of the houses of parliament. This is totally independent of the weekly communication of every kind of intelligence, and the keen investigation of a number of editors experienced on the subject, and solely engaged in such discussions. Indeed it is not one of the smallest marvels of the railway system to see one of these papers with more than thirty of our pages of close type recording the minutest details of railway management, and the most trivial observations of the humblest shareholder or official, for the perusal of many hundred railway directors, secretaries, engineers and functionaries. The loss of such auxiliaries consequent on the centralization of the railways by government, would deprive us of an engine of improvement which no other machinery could supply, even supposing the government to be willing at its own risk to keep up for the benefit of its functionaries a Railway Journal, or Railway Record, for even if it found the money it could not find the materials. Seeing the influence which this press has in the diffusion of intelligence and the propagation of truth, we are quite satisfied that the directors still holding out against low fares will not be for long.

"The grand remedy, however, we think, lies in improving the arrangements for obtaining acts of parliament. This our author has also turned his attention to, but we think he has not struck at the root of the evil. In common with many other individuals he has the customaay horror of projectors and share jobbers, and for the sake of remedying any evil connected with share jobbing, he is willing to sacrifice the interests of the community. We say give every facility for obtaining acts of parliament for railways, harbors, docks, bridges, and all useful works, take no trouble about whether the work will pay, or whether the parties have money to carry it on, leave them to look after that themselves, and do not for the fear of encouraging share job-

ng prevent people from carrying out useful works. Let such parties also ve the power of raising as much money as they can upon the work, and the parties lending the money look to their own investigations for the se-rity, and not to the legislature. We know these are views diametrically posed to the prevailing practice, but let them be canvassed and they will found to be right. Depend upon it, the more trade is left to regulate itself, d the more it is carried on by private enterprize, the better. The public very well able to protect itself, and to form its own judgment as to the ad-sability of an investment without any legislative aid on the score, which ter all is totally erroneous—for have not many of the lines, guaranteed by arliament to pay five per cent., been for years without a dividend, and others n the contrary surpassed all parliamentary calculations. As to the bubble ompanies, we have no fear on that head; West Middlesex swindlers may xist as they have existed, but a whole community is not to be fettered to pre-ent the perpetration of crime. Give every facility for obtaining railway ills, relax the standing orders, do away with all deposits, and you need en-ertain no fears about existing lines charging high fares. Here, too, we may bserve that nothing could be more absurd than the doctrine lately held in he legislature, that no new line should be authorized to compete with an ex-sting railway, for the more railways the better for the public at large. The dea, too, of the vested interest of a railway in the traffic between particular owns is supremely ridiculous, for it is evident that it did not regard the vested nterest of the turnpike road it superceded. No one can have a vested in-terest in abuse, and it is an abuse to subject the public to a high rate for tra-velling, when they can be carried more cheaply.

"The suggestions of the author, that the five per cent. government tax on railways might be appropriated as a tax for buying them up, is an exceed-ingly good one, and we think such a fund might be advantageously applied in the gradual purchase of shares at the market value without involving any great interference with the grand principle of private enterprize, for after all, what we have to look to is not what we shall do with the present railways, but how we shall keep up the national energy, by which such great works have been prosecuted, and by which still greater things can be effected in our own country, and in our vast colonial empire."

COST OF TRANSPORTATION.

The interesting and flattering statements of the Delaware and Hudson canal company, for 1842 and 1843, will be fresh in the recollection of our readers. We allude to them again in order to give some explanations which appear to us important. Since the åppearance of these statements in the *Journal*, we have been informed that the amount charged to the railway includes many miles of new line of road, as well as a very different arrangement of the entire "modus operandi" on the eastern side of the mountain. The canal has also been improved, hence the actual cost to the company cannot be stated with the accuracy we should desire, from any data in our possession. It will be seen that the greater quantity brought down in 1843 cost less than the smaller quantity of 1842; and it is probable that the next statement will show a still greater reduction. We have heard also that some portion of the coal was sold at three dollars and a quarter per ton. The account our informant gives us of the style in which the works are carried on, has made us desirous of a detailed account of the operations of the com-

pany, as far as they fall within the scope of the *Journal*, and when winter brings a little leisure we hope our wishes may be gratified. The results of the new arrangement are, we understand, highly favorable to the railway cause.

Mr. Nicolls, the superintendent of the Reading railroad, states the actual cost on that work, 93 miles long, to be 46 cents per ton, (*Journal*, March p. 83,) which is at the rate of 4·95 mills per ton per mile. The average load was 160 tons nett, and the return of the empty cars is included in the 4·95 mills per ton per mile.

The Baltimore and Ohio railroad company estimate the cost at ·941 cents per ton per mile, with loads of 210 tons, and ascending gradients of 264 feet per mile. In this estimate the cost of locomotive power is 2·28 mills per ton per mile, and with the gradients of the Reading railway this would be reduced one-half, and the estimate of the Baltimore and Ohio company would be $·941 - \frac{·228}{2} = ·827$ cents per ton. This is nearly twice the estimate of Mr. Nicolls, and it is obviously intended to be high enough. Again the latter gentleman may not include renewals of railway. In that event the account would stand thus—actual expenses, ·495 cents

Renewals of track, bridges, etc., - -	·250 "
Contingencies, - - - - -	·100 "
Total cost on Reading railway, - -	·845 cts. per ton per mile.

This agrees with the Baltimore and Ohio company's estimates very nearly.

While on this subject, we would observe that the objections to high grades may be carried too far, and that too many imagine that, because an engine on the Reading railway can draw twice as much as on most of our railways, therefore the cost of transportation will be reduced one-half. This investigation, however, to be thorough, requires a complete examination into the details of each peculiar case, and we must refer the reader to Mr. Ellet's papers, to Mr. Casey's paper, (Aug., 1839,) and to the report of Mr. Vignoles' lecture—the two former written for the *Journal*.

It will be remembered that the cost on the Cumberland canal is about the same, and the experience of Pennsylvania shows, that with boats of 70 tons burden, seven mills per ton per mile, even for long distances, yields but a sorry remuneration to the boatmen. Still coal is carried at that rate, and where the business is very great, and where small or nominal dividends only are expected, coal may be carried on some canals for one cent per ton per mile.

ATMOSPHERIC RAILWAYS.

We gave in the January number of this Journal, an article on "Atmospheric Railways," from the Glasgow "Practical Mechanic and Engineers' Journal." We now give further details in relation to this interesting subject, in a letter from one of the patentees, in reply to inquiries made by the South Carolina railroad company, through Messrs. Palmer, Mackillop and Co., of

ondon. In the Railway Times, of May 18th, we find the commencement f a report of an examination before a select committee of parliament, in which Mr. J. Samuda gives a minute description of the construction of the *tmospheric working* apparatus—to which we shall refer hereafter.

In our next number we shall republish most of a "Treatise on the daptation of *Atmospheric Pressure*, to the purposes of Locomotion on Railways;" with engravings, illustrating the mode of connecting the cars with the atmospheric apparatus; together with a statement of the cost of construction, and expense of working, as compared with the locomotive system—based upon actual operations.

This system, like all *new* theories, especially if of great importance, has to work its way against the prejudices of the community, and in this case against the interests of leading men connected with railroads in England—consequently its progress has been gradual, and mainly at the cost of those immediately interested in it; but if the statements now before us are to be relied on, we are of the opinion that it will at no distant day, *supersede* the present mode of working railways; and that the improvement in *safety*, *economy*, and speed will be *as great over the present system* as that is over the *almost* obsolete stage coaching of former days.

We give, in this number, a short extract from this treatise, which, if accurate, places the two systems in a position exceedingly favorable to the atmospheric. We shall be gratified to receive the views of our correspondents on this interesting topic for publication in the Journal.

We are under obligations, for these documents, to J. E. Bloomfield, Esq., who will please accept our thanks.

Mr. D. K. Minor: By the last steamer, I have been favored with a copy of Messrs. Samuda, Brothers' communication, giving the cost of laying down a mile of atmospheric railway, as well as the cost of working the same—being a reply to an application from a railway company in this country, who desire to dispense with stationary power, on an inclination of 360 feet to the mile.

It would appear by Messrs. Samuda's letter, that the atmospheric principle of motive power, costs 5½ pence sterling per train per mile to run 50 miles in the hour—while the *slow* locomotive engine, to run 25 miles per hour, costs 15 pence, or nearly three times as much, to run with half the speed, and with greater risk, as I understand it, to the passenger.

I would claim your notice of the remarks of the editor of the London Railway Times, of the 18th May, as well as the first part of the examination of Mr. J. Samuda before a committee of the house of parliament, also a description of his plan.

"To apply the subject"—allow me to ask, if the atmospheric railroad is what its friends claim for it, why not adopt this plan to make a railway to Albany? The charter of the New York and Albany company will cover the application of this principle, and as the objection heretofore has been that

a railway could not compete with the North river steamboats, it is to be hoped that this interesting subject will claim the early attention of our engineers and mechanics. We must not be behind England—in this "go ahead, age," particularly, when we have got Professor Morse's magnetic telegraph, to announce in forty seconds that 30 cars, carrying 1500 passengers, in three hours from this city to Albany, after breakfast, desire that the requisite arrangements be made for dinner, so as to be in time to take tea at Buffalo, over 320 miles of intervening railway.

Very respectfully, J. E. B.

Extract of a Letter from a Railway Company at Charleston, to which Messrs. Samuda's Letter is a Reply.

"We have on our railroad an inclined plane of 360 feet to the mile, which at present requires stationary power to overcome, but which we are desirous of dispensing with. From the examinations made, the operation will involve no little expense, and we have been deterred from proceeding by a notice which has appeared in the English Journals on the success of the atmospheric railroad between Dublin and Kingston. We are inclined to the opinion, from what we have read on the subject, and from our own calculations, that this atmospheric power may be applied most advantageously to planes, and particularly where the plane is not to be avoided but by a circuit and increase of distance, involving no ordinary expense—we will, therefore, esteem it a very great favor rendered to our company if you will obtain from General Pasley, R. E., J. Brunel, Esq., M. Mallet, or Mr. Vignoles, or from any other competent source, the real practical results of the experiment now making, with the cost of construction per mile, and the power exerted, with the advantages of this power compared with steam, on the various inclinations of a railroad. We would be pleased to have the arguments both pro and con., so that we shall be the better able to decide on the two questions which present themselves.

"*First.* The expense of reducing the grade of inclination at our plane by a circuit, and

"*Second.* The expense of overcoming the inclination and delay at the plane by the new power."

Copy of Letter from Messrs. Samuda, Brothers.

"*Southwark Iron Works, April* 30, 1844.

"Messrs Palmer, Mackillop & Co.

"Gentlemen: We beg to acknowledge the receipt of your inquiries respecting the atmospheric railway, and in reply beg to hand you the following information which we regret will not, in all probability, be as complete as your friends might wish, owing to the want of some information which their letters do not supply, and which we would feel obliged by your obtaining for us. Thus, the *length* of the inclined planes is not named. We can only, therefore, in the present instance, give them such general information as we hope may be useful.

"The diameter of the vacuum pipe which we recommend in all ordinary ses is 15 inches; this will draw

0 tons on a level,	48 tons up 1 in 80,
0 " up 1 in 160,	44 " " 1 " 70,
5 " " 1 " 120,	39 " " 1 " 60,
8 " " 1 " 100,	33 " " 1 " 50.

"Up such an incline as you name (360 feet per mile, or 1 in 15 about,) will take 12 tons, which, in all probability, will be too small a load, if so, owever, the area of the pipe will require to be increased till it meets the oad you deem sufficient—probably 20 to 25 tons will suffice, in which case pipe of 22 inches diameter will be required on that incline.

"The engine power necessary depends on the speed you require the trains o travel—thus with a pipe 15 inches diameter, (which is capable of drawng any of the loads on the corresponding gradients mentioned in the annexed table,) an engine of 100 horse power will be sufficient for a speed of 50 miles per hour, or 68 horse power for 30 miles per hour.

"The distance apart the engines should be placed will be slightly influenced by local circumstances, but will average 3½ miles from each other. We have subjoined a table showing the working expenses on the atmospheric system on a long line of railway, similar to the London and Birmingham here, and performing the same amount of traffic; from that statement, the cost of haulage on the atmospheric system, travelling at 50 miles per hour, is - - - - - - $5\frac{1}{10}d.$ per train per mile,
while the present cost with locomotives, at the
present speed of 25 miles per hour, is 1*s.* 3*d.* " "

"In the maintenance of way there is also a saving on the atmospheric system, for the destruction caused by the locomotive engine to the rails, and the way itself, is entirely avoided; and in its stead, we have only the expense of attending the mains, and which in practice we find fully provided for with one laborer per mile.

"The cost of the atmospheric apparatus will of course be slightly influenced by local causes, the price in London will be as follows:

15 inch vacuum pipes, about 309 lbs. per yd. = 272 tons per mile at £6, - - - - - -		£1632 per mile.
"Continuous valve and fastenings, viz;		
Wrought iron plates and bars, 18½ tons, -	£129	
Leather, 42 cwt., - - - - - -	324	
Bolts and nuts 24 cwt., - - - -	67	
Labor, rivets, oil, tools, etc., - - - -	250—	770 " "
Tallow lining and composition for grove, - -		250 " "
Planing, drilling and lining with tallow, 3*s.* 4*d.* per yard,		295 " "
Station valves, about - - - - - -		50 " "
Travelling piston and gear, - - - -		50 " "
		£3047 " "
Drawings, superintendence, specifications, etc., say 5 per ct.,		153 " "
		£3200 " "

"The cost of a vacuum main, 22 inches diameter, will be £4200 per mile.

"Table of working expenses of the atmospheric system referred to, on a line similar to the London and Birmingham railway, 112½ miles long, and performing a similar traffic.

Coal—each engine burns 500 lbs. per hour, and works for each train - - -	8¼ min.	
Add for waste while standing, 1*s*. 3*d*., -	2¾ min.	
	11 min. = 92 lbs.	
32 engines × 92 lbs. = 2944 lbs., or 1 ton 6 cwt. 1 qr. 4 lbs., at 9*s*.,		11*s*. 10 *d*.
Wages—33 engine stations, each 2 men at 6*s*. / " " " 3*s*.	18*s*. $\frac{18 \times 33}{30 \text{ trains}}$,	19*s*. 9 *d*.
Repairs to engines, oil, hemp, etc., 5 per cent. on cost, say per year, $\frac{£212\ 10s. \times 33}{30 \text{ trains} \times 365 \text{ days}}$ - - - - -		12*s*. 10 *d*.
Piston leather 2*s*., charcoal 6*d*., wear and tear of travelling gear 4½*d*.,		2*s*. 10½*d*.
Superintendence, clerks, foremen and office expenses, say £2500 per annum, $\frac{£2500}{33 \times 365}$, - - - - - -		4*s*. 6½*d*.
Total haulage = $5\frac{5}{16}d$. per mile, - - -		51*s*. 10 *d*.

"Any other information which your friends may require, we shall at all times be happy to furnish. We are, etc.

[Signed,] "Samuda, Brothers."

Messrs. Samuda, Brothers, having omitted to state the cost of stationary engines, they write on 10th May as follows:

"We regret that we should have omitted the price of the stationary engines in our particulars of the atmospheric apparatus furnished you.

"The price of two 50 horse condensing engines with their vacuum pumps and apparatus complete in every respect, and put on board a vessel in the Thames, will be - - -	£4250
"A pair of 34 horse engines and pumping apparatus as above,	3000."

ON THE ATMOSPHERIC SYSTEM.

"1st. The loss of power occasioned by the locomotive engines having to draw their own weight is entirely avoided, and steep hills may be ascended with no more additional power than that actually due to the acclivity, as there is no weight except the train.

"There is no other known power which can be applied to locomotion without carrying considerable weight and friction with it. The ill effects of locomotive engines have been already pointed out, and the same disadvantages exist in the application of ropes, which must be drawn along with the train, and become an increased incumbrance on inclined planes. The defects of ropes in other respects are too generally known to need comment.

"2d. The weight of the rails and chairs on the new system may be less by one-third than where locomotive engines are employed, as the carriages of the train will be too light to injure them. The annual charge of maintenance of way will, from the same cause, be reduced to a considerable extent.

"3d. The wear and tear of locomotive, compared with stationary engines, is as 18 to 1.

"4th. By the new system the full power of the engines is always obtained; and on an incline the additional quantity of fuel consumed in ascending will be saved in descending, as the trains run down by their own gravity. The expense of fuel will be further decreased, as the expense of using coal is only half that of coke.

"On the new system the velocity depends entirely upon the velocity with which the air

hdrawn from the pipe; therefore, by simply increasing the air pump, any speed may ained; and with a fixed quantity of traffic per diem, no considerable increase in the onsumed or any other expense is incurred for improving speed, further than the small ional power required to overcome the increased atmospheric resistance. An actual g in the first cost of a railway constructed for high velocities may be effected, because rforming the journey in less time, a greater number of trains may be despatched each and their weight diminished; therefore the piston, having less to draw, may be smaller ameter. The cost of the pipe (which forms the largest item in the first cost of this ay) will thus be reduced in nearly the same proportion as the speed is increased.

Besides these advantages, the system possesses others of still more importance to the ic. No collision between trains can take place, for as the power cannot be applied to than one piston at a time in the same section of pipe, the trains must ever be the th of a section apart from each other; and if from any cause a train should be stopped he middle of a section, the train which follows it will be obliged to stop also at the en-ice of the pipe, as there will be no power to propel it until the first train is out. It is impossible for two trains to run in opposite directions on the same line, as the power nly applied at one end of each section. A train cannot get off the rail, as the leading riage is firmly attached to the piston, which travels in the pipe between the rails, and luggage and carriages cannot be burnt, as no engines travel with the trains.

'We now come to the comparative cost of the two systems.

'1st. The necessity of having the railway comparatively level causes the present enor-ous outlay for earth work, viaducts and tunnelling, and increases the cost of land, not ly by lengthening the line to save cutting and embankment, but by the quantity wasted each side of the road wherever such work is required. Thus, if an embankment or tting has to be made of 30 feet, at least 60 feet of land must be covered on each side of e railway in order to obtain sufficient slope, making a width of 120 feet, besides the road, cept where they occur in very favorable ground. The comparative expense of this item, tween the two systems can be ascertained by referring to the average cost of forming a rnpike road and that of the principal railroads now in operation.

"Since it is not necessary to make detours to avoid steep gradients, the direction of the oad in a straight line may be more nearly preserved."

LOCOMOTIVE SYSTEM.	Per mile.
Taking five of the principal railroads as the basis of our calculation, their average expense of formation has exceeded*	£36,000
And the original stock of locomotives,	1,600
	£37,600

ATMOSPHERIC SYSTEM.	Per mile.
The average expense of forming a turnpike road throughout England has been £3000 per mile, but for our road say	£4,000
Allow extra for road bridges,	2,000
Rails, chairs, sleepers and laying down,	2,500
Main pipe and apparatus complete (on a scale for transporting 360 tons per hour, or 5000 tons per day of fourteen hours, on a road with gradients of 1 in 100),	5,200
Fixed engines, air pumps, and engine houses,	1,400
Travelling pistons,	20
	15,120
Saving per mile in forming and furnishing on the atmospheric system,	22,480
	37,600

Annual expenses of working per mile, when conveying two thousand tons per day. (This is beyond the average quantity conveyed on the Liverpool and Manchester railroad:)

LOCOMOTIVE SYSTEM.	Per mile.
5 per cent. interest on capital invested, £37,600,	£1,880
Maintenance of way,	450
Locomotive department, including coke,	1,800
	4,130

ATMOSPHERIC SYSTEM.	Per mile.
5 per cent. interist on capital invested, viz., £15,120,	£756
Maintenance of way, and attendance on mains,	300
Wear and tear of fixed engines, 5 per cent. of cost,	70
Coal, 0·75 lb. per ton per mile, 214 tons, at 20s.,	214
Wages to enginemen and strokers,	60
	1,400

*Our calculations are founded on the reports of different companies whose railways are complete, or in a forward state.

	1,4[illegible]
Wages to train conductors, - - - -	25
Renewal of travelling apparatus and composition, - -	50
Sundries, - - - - - -	150
	1,626
Annual saving per mile on the atmospheric system, - -	2,504
	4,130

Total expenses per ton per mile on the locomotive system, - -	15[illegible]
" " " atmospheric " - -	[illegible]

Exclusive of carriages and management, which may be taken as the same on both systems.

MISCELLANEA.

There is a very interesting though somewhat discursive article on "Aqueducts and canals" in the London Quarterly Review, for March last. It will perhaps astonish the advocates of canals to learn that the Duke of Bridgewater regarded with no little uneasiness, and with almost incredible foresight, the ultimate capabilities of the railway, though at that time nothing beyond the common tramroad existed. When congratulated on at length reaping the profits of his perseverance and sacrifices, he replied "Yes, we shall do well enough if we can keep clear of those d—d tramroads."

The Croton aqueduct is also mentioned in these flattering terms: "Till London with all its water companies is as well supplied with accessible water as modern Rome is by only two of the aqueducts, whether fourteen as some count them, or twenty, which ancient Rome possessed, we must content ourselves, Anglo-Saxons as we are, with resorting to New York for wise saw and modern instance, and must lead our readers to drink at the Croton aqueduct."

The reviewer has got it into his head that there is some doubt as to the work accomplishing its object. The only objections we have heard are that the deviations from the original plan in the Harlem bridge and dam in the Croton have cost the city several hundred thousand dollars, and that architectural effect appears to have been avoided not by an increase, but certainly without any diminution of expenditure. There having been no estimate of income, and the expenditure having been in fact "ad libitum," the Croton water works have escaped the searching and infallible ordeal through which the railway has to pass. But as regards the supply of water with reference to quality and quantity, there can be no doubt as to the excellence of the former, or the abundance of the latter.

The Mohawk and Hudson railroad company having done away with the use of the inclined plane at Schenectady, are now engaged in building an entire new road at Albany, in order to avoid the inclined plane at that city.

The Long Island railroad company are making a tunnel in Atlantic street, Brooklyn, in order to bring the engines near the ferry, and to do away with the use of horses. It will also save time, and thus aid them in competing for the Boston travel. Should this meet the eye of the engineers of the above important works, we would beg leave to intimate that some details as to the annual cost on the old plan, the saving by the new and the outlay by which

that saving is effected would be of interest to our readers generally, and, as we have in another part of this number endeavored to show, would be attended with no disadvantage to themselves.

The Central railroad (Michigan) will be opened in July to Marshall, and in the fall to Kalamazoo.

Enlargement of the Lachine Canal.—"In the list of imports by the Lachine canal in this day's Gazette, will be found the cargo of the Quebec forwarding company's barge Shannon, consisting of 1903 barrels of flour. This, we are informed, is the largest cargo ever brought from the upper country to this market, by about 400 barrels."—[Montreal paper.]

Here it will be seen that a wooden canal boat, which passes the old locks of this canal, has actually brought down 190 tons of freight. An iron boat would take 250 tons. Now we know that 100 boats per day can be passed through single locks with ease, and—we quote from memory—the total amount of western produce, via the St. Lawrence, does not exceed 600,000 to 700,000 barrels per annum; and 100 boats with 1900 barrels each, gives 190,000 barrels per day. Hence, the old Lachine canal will easily pass the western freight in 5 or 6 days, and would not require more than 10 or 12 days to pass all the flour and pork which passes over the Erie canal. Yet the former is to be enlarged from 20 × 100, (the size of the present locks,) to 45 × 200, and the channel of the canal in proportion. The "Canals of Canada" have, however, been thoroughly discussed in the Journal, and we only allude to them now to show that the views of the writer are fully borne out by experience, and also to give a practical and striking example of the ruinous consequences which infallibly result from entrusting to political adventurers the management of works, to the success of which that character and skill, which we have strongly insisted on in our opening article, so largely contribute, and without which all is a lottery.

RATES OF FARE AND RATES OF SPEED ON RAILROADS.

In our number for April we presented some considerations on this subject, and cited the case of the line of railroads between New York and Washington, as one on which rates of fare, much higher than could be judicious, were adopted. Our impression is that the prosperity of this route of travel has been much retarded by these rates, which have a tendency to throw off the travel on other routes, and at the same time to prevent the increase which at more reduced rates would take place between the cities which it connects. At the same time, it was evident to us, that the present rates of fare, if continued, must lead to rival lines being gotten up between these cities, of an inferior character perhaps, but at more reduced charges to the traveller, which would carry off much of the aliment pertaining to these works; and as friends of the railroad system, *reluctant to see it retrograde*, we were anxious to see a policy adopted, which, while it was liberal to the public, was *the true policy* for the railroad companies. At a rate of from $2 to $2 50 between New York and Philadelphia, the same between Philadelphia and Baltimore, and from $1 to $1 50, at farthest, between Baltimore

and Washington, and with not more than four and a half hours between New York and Philadelphia, and from five to five and a half between Philadelphia and Baltimore, the railroads connecting these towns may monopolize the whole travel between them, and that greatly increased, probably much more than doubled, by such a policy; but we predict if the present high rates of fare, and low rates of speed, on this great line are continued, a year will not elapse before rival lines of steamboats and stages will be established throughout its whole extent; and if established they will be sustained, both because at the present reduced prices of labor, provisions and materials they will be kept up at a comparatively reduced cost, and because the public, which considers its good nature to have been abused by the railroad companies, will be inclined to support them. We trust that the railroad companies will look calmly at the subject, and see to what they are at present exposed by their too grasping policy, and mistaken views of it, and as we expressed ourselves in our previous number, on the subject, will "act on the principle of the ounce of prevention being worth the pound of cure."

It is apt to be the case that we are not apprehensive of danger where we have been for some time exposed to it, and the companies in question, having so far escaped any direct competition, may perhaps think themselves safe from it. But they should bear in mind that the country is no longer in the prostrate condition in which it has been since the revulsion of 1837, and that a spirit of enterprize is now abroad, which will leave unexplored no avenue to profit. Ericsson boats have been already built, and more are building, for the conveyance of freight and passengers between New York and Philadelphia, New York and Richmond, and Philadelphia and Richmond. These boats may be expected to divert some travel from the railroad lines, but nothing in comparison with what would be taken from them by lines of stages and steamboats at a reduced rate between New York and Philadelphia, and Ericsson steamboats between Philadelphia and Baltimore, by way of the Chesapeake and Delaware canal, or a line of very quick steamboats on the Delaware river, and Chesapeake bay, connected by an expeditious stage line between Newcastle and Frenchtown, or parallel to the Chesapeake and Delaware canal. An *independent* canal line, or a day line of quick, steamboats could not fail to do well at half the present rates of fare charged by the railroad company between Philadelphia and Baltimore.

We say an *independent* canal line, because there is at present a daily line of Ericsson boats between Philadelphia and Baltimore on the canal route, but these it is generally understood are owned by the railroad company, or large stockholders in it, and are now, *not* to make money by the transportation of passengers, but rather to keep travel *from* the canal, and throw it on the railroad, the rates with this view being kept nearly as high by the canal line as on the railroad itself. The fact that few travellers under these circumstances take the canal route, is no evidence that a really effective line on the canal would not carry off a very large travel. On the contrary we are very much mistaken, if a night line on this route would not compete even at

the same rate of fare very advantageously with the railroad; and, therefore, if once gotten up and prosperous, there would be no probability of the railroad company putting it down, or buying it up without a great sacrifice.

Instead of adopting a policy which will certainly bring about these results, we would earnestly urge the companies between this and Baltimore to look to the other side of the picture, and see what may be done by diminished rates of fare and increased speed. In the first place their example would be followed by other railroad companies south and west of them, and the whole of that travel which is now diverted to the sea, and passes between the north and south in sloops and schooners, or which passes up the Hudson, and thence around by the great lakes, even to New Orleans, would pass over their railroad and the Baltimore and Ohio railroad to Wheeling, or by the railroads south of Baltimore to the south and south-west. Secondly, the local travel between the large cities would be greatly increased. But, lastly, and what seems to us of much more moment than any other consideration, the companies would establish the prosperity of their works on a more permanent foundation, both by doing away with the temptation which now exists to competition, and by satisfying the public which is at present universally impressed with the opinion that the fares on the great routes in question are *too high*, and their rates of speed *too slow*, and that in other respects *it is not accommodated on them as it ought to be.*

Our thanks are due to the Hon. Asher Tyler, the Hon. Horace Wheaton and the Hon. Hamilton Fish, of the House of Representatives, for public documents—recently received.

Elihu Burritt expresses himself as follows in relation to the "iron horse" of the railroad: how few there are who can do it more eloquently. "I love," says he, "to see one of these huge creatures, with sinews of brass and muscles of iron, strut forth from his smoky stable, and, saluting the long train of cars with a dozen sonorous puffs from his iron nostrils, fall gently back into his harness. There he stands, champing and foaming upon the iron track, his great heart a furnace of glowing coals; his lymphatic blood is boiling in his veins; the strength of a thousand horses is nerving his sinews—he pants to be gone. He would 'snake' St. Peter's across the desert of Sahara, if he could be fairly hitched to it, but there is a little sober eyed, tobacco chewing man in the saddle, who holds him in with one finger, and can take away his breath in a moment, should he grow restive and vicious. I am always deeply interested in this man; for, begrimed as he may be with coal, diluted in oil and steam, I regard him as the genius of the whole machinery, as the physical mind of that huge steam horse."

Fitchburgh Railroad.—The cars on this road made their first appearance at Concord on Thursday, June 6th, and the trains will now run regularly; the track is progressing rapidly towards Vermont, and—Canada? *certainly.*

Since the above, we have received a copy of their report, and shall refer to it in our next.

Railroad Accident—on the Syracuse and Auburn railroad, on Wednesday evening, 5th June, says the Rochester daily Advertiser, without other injury than what was sustained by the "iron horse." Would it have occurred if the cars had been moved on the "atmospheric" principle? *Mr. Samuda,* one of the inventors, says it is impossible.

Norwich and Worcester Railroad.—The Norwich Courier, of June 4th, says that the annual meeting of the stockholders of the Norwich and Worcester railroad took place in this city yesterday. The following gentlemen were elected directors for the ensuing year: D. Tyler, W. P. Green, J. A. Rockwell, Norwich; A. DeWitt, Oxford. W. W. Ward, Boston; S. R. Brooks, Jacob Little, Elihu Townsend, John Rankin, Alfred Brooks, New York; Asa W. H. Clapp, Portland, Me.

It is said that is in contemplation to extend the Long Island railroad seven miles beyond Greenport, bringing its terminus to within fourteen miles of New London. Another project on the tapis is to extend the Norwich and Worcester road down the river to a point opposite or below New London, so that the termini of the two roads shall be brought within 13 or 14 miles of each other. Thus this route between Boston and New York would be substantially a land route. If, then, the distance from New York to the eastern terminus of the Long Island road—one hundred and one miles—shall be accomplished in three hours—no more and no less—(and that is what the company confidently expect to do) the route will inevitably be the quickest, surest and most popular route between the two cities. As such, it is sure, also, to become the great mail route.

Boston and Worcester Railroad.—The stockholders, at their annual meeting on Monday, 3d June, says the Bay State Democrat, re-elected Messrs. Nathan Hale, David Henshaw, Daniel Denny Eliphalet Williams, George Morey and Nathaniel Hammond, directors—and chose Messrs. John Hathaway, Abraham T. Low and Benjamin F. White, in place of Messrs. Moses Williams, Addison Gilmore and Nathaniel F Emmons, who declined a re-election. The annual report was submitted and ordered to be printed.

We have received a copy of the report—from some kind friend, who will please accept our thanks—but have not yet had time to examine it, will do so, however, in time for our next number.

Boston and Providence Railroad.—At the annual meeting of the stockholders of the Boston and Providence railroad, the old board of directors were re-elected. The receipts from January 1st, 1843, to January 1st, 1844, have been $98,821, against $75,620 in the same time of 1843—increase $23,201. The month of June is estimated at $26,000—last year, $23,749. The expenses have been materially less than in 1843, and the nett revenue for the past six months will be nearly equal to what it was when the whole New York business was done by this road. It was voted to subscribe $40,000 in aid of the Stoughton Branch railroad, which insures its being built, and will give a large addition of business to the Providence. The freight has increased this year 96 per cent to way stations, and 11 per cent. to New York.—[N. Y. American.]

Greenfield and Northampton Railroad.—We learn, says the Greenfield (Mass.) Democrat, that Mr. Hoyt, is making good progress in the survey of this road. From a point a little this side of Northampton, for the distance of about 11 miles, the road can be made in a right line "as straight as an arrow," and perfectly level. The country is so level that the expense of grading that part of it cannot exceed one thousand dollars per mile. So favorable a location for a railroad can scarcely be found in "New England." The distance from Greenfield to Northampton, by the railroad, will be 18 1-2 miles.

Another Railway.—The Hartford papers recommend the construction of a railway from that city to Danbury, for the purpose of forming a direct railway communication from Boston and Hartford to New York; in opposition to the proposed railway from New Haven to Bridgeport. The distance from Hartford to New York via Danbury it is estimated can be performed in four hours. The highest gradients will not exceed 40 feet per mile, and the road will pass through Waterbury and several manufacturing villages.

At an election of directors of the Mohawk and Hudson railroad company, held on the 12th inst, the following persons were elected directors for the ensuing year: George Law, Jacob Little, Edward Mills, Wm. S. Hoyt and John B. Lasala, of New York; Rufus H. King, Augustus James, Herman Pumpelly and John V. L. Pruyn, of Albany. And at a meeting of the board held the same day, George Law was re-elected president and Jacob Little vice president.

CONTENTS:

AMERICAN

RAILROAD JOURNAL,

AND

MECHANICS' MAGAZINE.

Published Monthly at 23 Chambers-st. New York, at $2 a-year, in advance, or 3 copies for $5. | D. K. MINO, Editor.

No. 8, Vol. 2. Third Series. | AUGUST, 1844. | Whole No. 439. Vol. XVII.

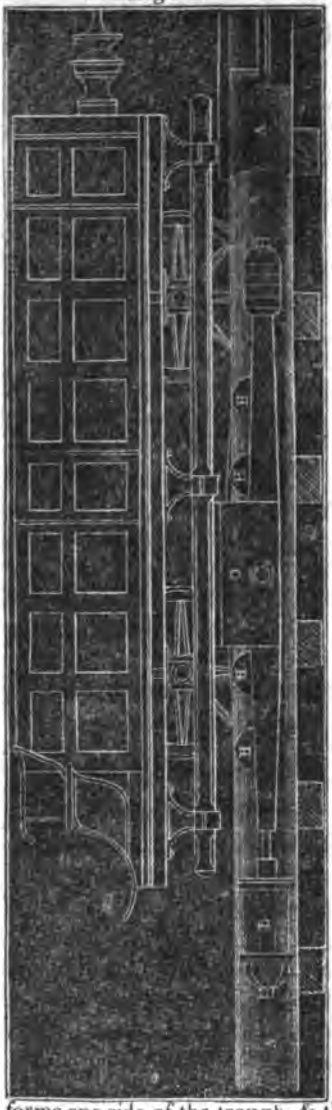
ATMOSPHERIC RAILWAY.

In our July number we published a letter from Messrs. Samuda, Brothers, the patentees of this new mode of working railways, and promised to give in a subsequent number, a further description, with illustrations. In accordance with that promise we now give the main part of a short "treatise on the adaptation of atmospheric pressure to the purposes of locomotion on railways," by M. J. D'A. Samuda, together with several extracts from the examination of Mr. *Cubit*, Mr. *S. K. Brunel*, and Mr. *Robert Stephenson*, engineers of reputation, before a committee of the house of commons, in relation to its advantages as compared with the present locomotive engine system of working railways. Mr. Stephenson appears to take decided ground against the principle, yet he admits that "its safety is nearly perfect if you keep the trains moving in one direction, at the same time"—that is to say there is no danger of running off the track—or the only danger of accident arises from the possibility of two trains meeting, of which it seems to us there is little probability; but the other gentlemen were *decidedly* in its favor, as the extracts from their examination will show; and, "the decision of the committee was unanimously given in favor of the Croydon and Epsom line to be worked by the atmospheric system, to the exclusion of the other."

It is by no means surprising that there should be a diversity of opinion among gentlemen of the profession, as well as others, in relation to an invention which, if it is in reality what its friends claim for it, bids fair to produce a *revolution* in the present mode of railroad locomotion. And even Mr. *Stephenson*, high as he stands as an engineer, and manufacturer of *locomotive engines*, may be as much mistaken, and as honestly so too, as was Dr. *Lardner* in relation to Atlantic steam navigation; but we see no reason to doubt the accuracy of the experiments and the correctness of the observations made by the other gentlemen who were examined by the committee. At all events, we think we see enough in it to warrant us in laying it before our readers, and to request those editors with whom we exchange to do the same to theirs, or to call attention to the Journal containing it.

DESCRIPTION OF CLEGG AND SAMUDA'S ATMOSPHERIC RAILWAY.

Fig. 1.



On this system of working railways the moving power is communicated to the train by means of a continuous pipe or main A. laid between the rails, and divided by separating valves into suitable and convenient lengths for exhaustion; a partial vacuum is formed in this pipe either by steam engines and air pumps fixed at intervals along the road, or by water power, if the nature of the country be such as to afford it— These valves are opened by the train as it advances, without stoppage or reduction of speed. A piston B, which is made to fit air tight by means of a leather packing, is introduced into the main pipe* and connected to the leading carriage of each train by an iron plate C, which travels through a lateral opening the whole length of the pipe. This lateral opening is covered by a valve G, extending the whole length, formed of a strip of leather riveted between iron plates, the top plates are wider than the groove, and serve to prevent the external air forcing the leather into the pipe when the vacuum is formed; the lower plates fit the groove when the valve is shut, and making up the circle of the pipe, prevent the air passing the piston; as shown in figs. 2, 3 and 4. One edge of this valve is securely held down by iron bars *a a*, fastened by screw-bolts *b b* to a longitudinal rib *c*, cast on the pipe on one side of the lateral opening, and the leather between the plates and the bar being flexible, forms a hinge as in a common pump valve; the other edge of the valve falls on the surface of the pipe on the opposite side of the opening, thus forming one side of a trough F, as shown in figs. 2, 3, 4. This trough is filled with a composition of bees' wax and tallow, which substance is solid at the temperature of the atmosphere, and becomes fluid when heated a few degrees above it. This composition adheres to the edge of the valve, which forms one side of the trough, & that part of the pipe which forms the other, & produces perfect contact between them; but as the piston advances, the valve G must be raised to allow the connecting plate C to pass, and this is effected by four wheels H H H H fixed to the piston-rod behind the piston, and the aperture thus formed serves also for the free admission of air to press on the

* When the first division or section is exhausted, the separating valve is opened, and the front of the piston being thus exposed to the exhausted portion of the pipe, the atmospheric air pressing on the back of it propels it forward in the pipe, and with it the train to which it is attached.

back of the piston: by this operation of raising the valve out of the trough, the composition between it and the pipe is broken, and the air-tight contact must be reproduced. To effect this, another steel wheel R is attached to the carriage, regulated by a spring which serves to insure the perfect closing of the valve by running over the top plates immediately after the arm has passed, and a copper tube or heater N about 5 feet long, filled with burning charcoal, is also fixed to the under side of the carriage, and passes over and re-melts the surface of the composition which has been broken by lifting the valve, and which upon cooling becomes solid, hermetically sealing the valve as before.

Fig. 2.

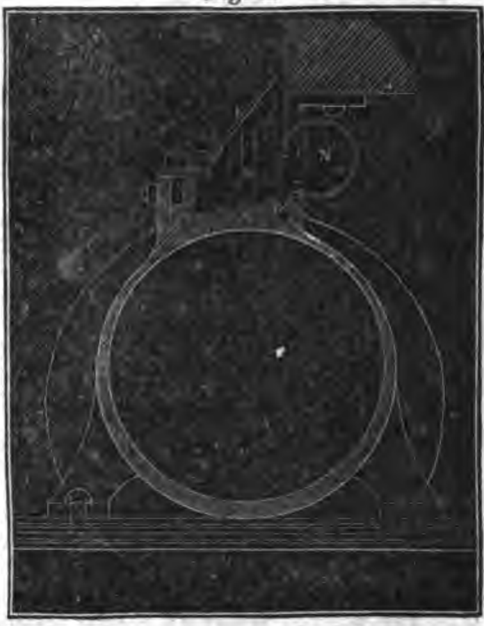
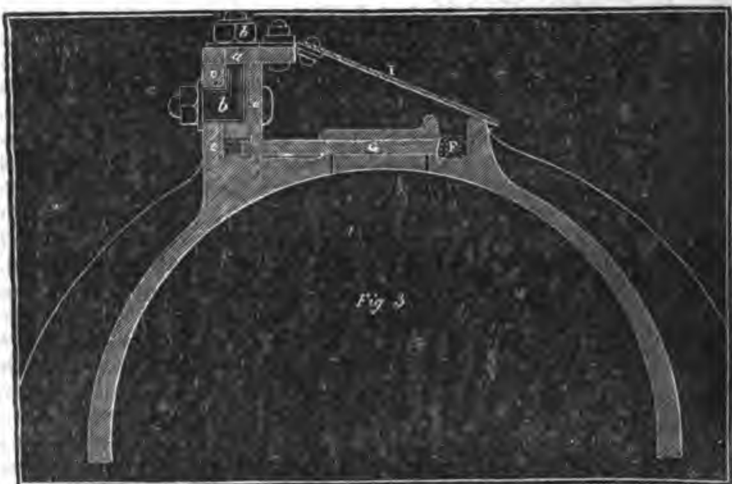


Fig. 3.



Thus each train in passing leaves the pipe in a fit state to receive the next train. A protecting cover, I, formed of thin plates of iron about 5 feet long, hinged with leather, is placed over the valve, and serves to preserve it from snow or rain; the end of each plate underlaps the next in the direction of the piston's motion, thus insuring the lifting of each in succession, which is effected by the wheels D fixed under the carriage.

Fig. 4.

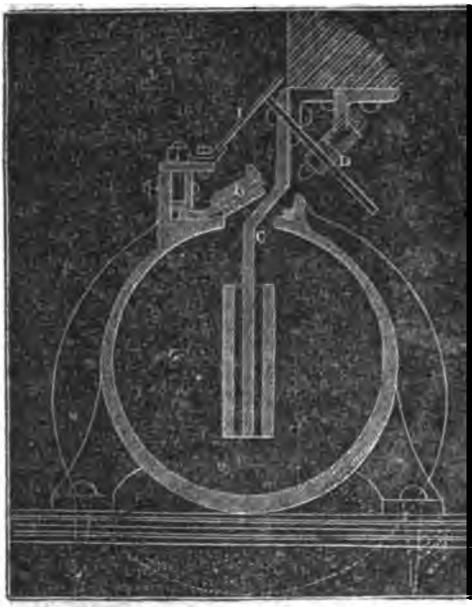


Fig. 5 is the *exit* separating valve, or that at the end of the section nearest to its steam engine; this valve is opened by the compression of air caused by the piston after it has passed the branch which communicates with the air-pump.

Fig. 6 is the equilibrium or *entrance* separating valve. The arrow denotes the direction in which the trains advance. The pipe is exhausted on the side of the valve letered C, and is only prolonged on the other side to allow the piston to enter the pipe before the valve is opened. Attached to one side of the main is a semicircular box B A, divided into two compartments by a partition, of which *a a a* is a sectional view, and thro' which is a circular opening: in the top of the box are two small square holes, one on each side of the partition, furnished with a box slide, by which either or both of them may be covered at pleasure; within the box B A are two valves, *b* and *c*, (of which *b* is the greater,) connected by an arm *d d* to each other, and to a vertical axis *e*, on which they can swing horizontally for about 100 degrees. When the pipe is to be exhausted, the valves are placed by hand or otherwise, in the position represented in the figure; *b* filling the opening in the partition, *c* closing the main. The box slide also covers the hole on the side B of the partition, leaving the other hole open as the exhaustion proceeds; C and B are in vacuum; A and D open to the air. There is then the same pressure on each square inch of *b* and *c*; but *b* being larger than *c* both remain close, for the total pressure on *b* preponderating, will keep *c* against its seat, as will be plain on looking at the figure. But the train on approaching, moves the slide box so as to cover both holes, and a passage is formed thro' which the air in the partition A, rushes into the main C, so that A and B are both in vacuo, and the pressure being removed from *b*, that on *c* forces

Fig 5.

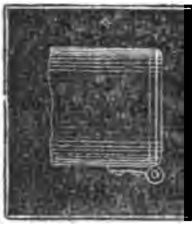
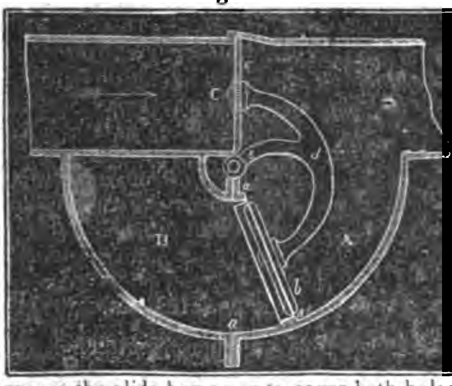
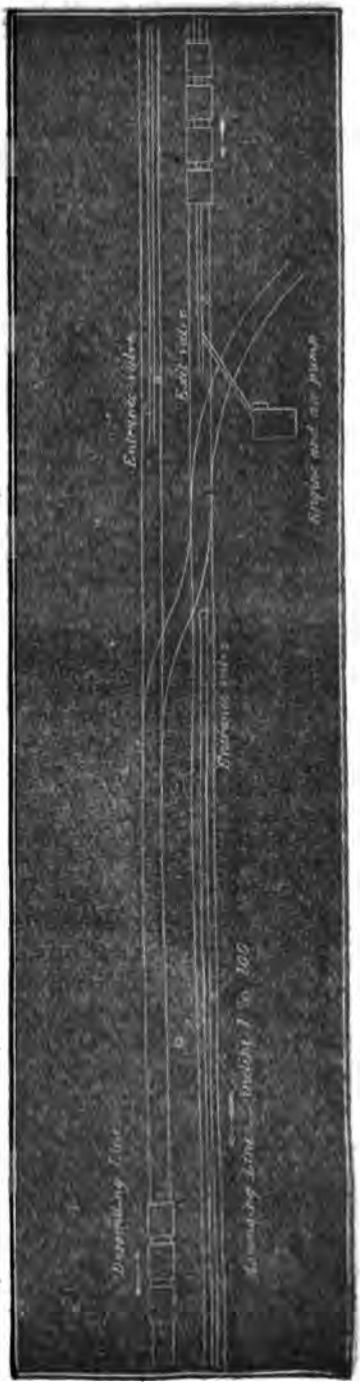


Fig. 6.



it back and allows the piston to pass.—The valve, or rather, piston *b*, is a cup leather, riveted between iron plates and shuts *into* the opening in the partition: *c* is a flat leather valve, and shuts *against* a facing in the main.



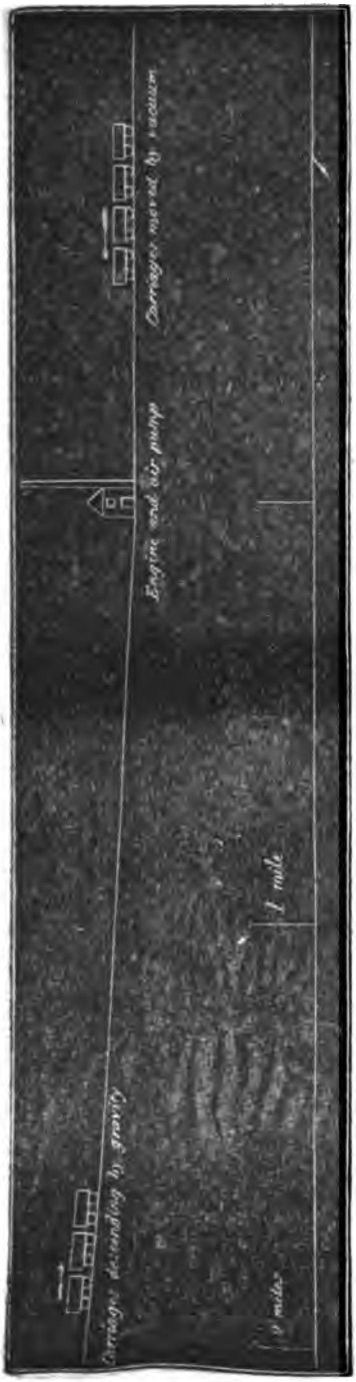
The main pipe is put together with deep socket joints, in each of which an annular space is left about the middle of the packing, and filled with a semi-fluid; thus any possible leakage of air into the pipe is prevented.

When it is necessary to stop or retard the train, in addition to the use of a common break, a valve in the travelling piston is opened by the conductor by which means the external air is admitted into the exhausted portion of the pipe, and the propelling power destroyed.

In localities where a sufficient quantity and fall of water can be obtained, the atmospheric system can be worked without the assistance of any machinery whatever: by constructing a tank or tanks (of a total capacity double that of the section of pipe they have to exhaust,) filling them with water, and allowing it to run out through a descending perpendicular pipe about 32 feet long (which it will do by its gravity alone,) the whole of the air contained in the pipe will expand itself into the tanks, and by the time they are half emptied of water half a vacuum will be formed in the pipes, as the air will be expanded into twice its bulk, and the other half will run out while the travelling piston and train are advancing, thus increasing the space in the tanks as that in the pipes is diminishing by the approach of the piston, and by this means maintaining the same degree of vacuum during the whole time the train is passing, whatever be its speed.

Workings of the Atmospheric railway on the Birmingham, Bristol and Thames Junction railway.

The system is in operation on part of the above line between the Great Western railway and the Uxbridge road, on an incline, part 1 in 120 and part 1 in 115.



The vacuum pipe is half a mile long, and 9 inches internal diameter.

The exhausting pump is $37\frac{1}{2}$ inches diameter and $22\frac{1}{2}$ inches stroke, worked by a steam engine of 16 horses' power.

For the purpose of experiment a series of posts were fixed along the half mile every two chains, and a barometric gauge was attached at each end of the pipe, for the purpose of ascertaining the degree to which the pipe was exhausted; a vacuum equal to a column of mercury 18 inches high was obtained in about one minute, and both gauges indicated the same extent of vacuum at the same instant.

The following table shows a fair average of the results obtained during six months.

By following out these results, it will be found that a main pipe of 18 inches diameter will be sufficiently large for a traffic of 5000 tons per day, viz., 2500 tons in each direction, supposing the gradients of the road to average 1 *in 100.*

Note.—A main pipe, 18 inches diameter, will contain a piston of 254 *inches* area: the usual pressure on this piston, produced by exhausting the pipe, should be 8 lbs. per square inch (as *this* is the most economical degree of vacuum to work at, and a large margin is left *for obtaining* higher vacuums to draw trains heavier than usual on emergencies)—a tractive force of 2032 pounds is thus obtained, which will draw a train weighing 45 tons, at 30 miles per hour, up an incline rising 1 in 100. Two and a half miles of this pipe will contain 23,324 cubic feet of air, $\frac{16}{30}$ths of which, or *12,439* cubic feet, must be pumped out to effect a vacuum equal to 8 lbs. per square inch: the air-pump for this purpose should be 5 feet 7 inches diameter, or 24·7 feet area, and its piston should move through 220 feet per minute, thus discharging at the rate of $24{\cdot}7 \times 220 = 5434$ cubic feet per minute at first, and at the rate of 2536 cubic feet per minute when the vacuum has advanced to 16 inches mercury, or 8 lbs. per square inch, the mean quantity discharged being thus 3985 feet per minute: therefore $\frac{12439}{3985} = 3{\cdot}1$ minutes, the time required to exhaust the pipe; and as the area of the pump piston is 14 times as

great as that in the pipe, so the velocity of the latter will be 14 times as great as that of the former, or 220 feet per minute × 14 = 3080 feet per minute, or 35 miles per hour: but in consequence of the imperfect action of an air-pump, slight leakages, etc., this velocity will be reduced to 30 miles per hour, and the time requisite to make the vacuum increased to 4 minutes: the train will thus move over the $2\frac{1}{2}$ miles section in 5 minutes, and it can be prepared for the next train in 4 minutes more, together 9 minutes; 15 minutes is therefore ample time to allow between each train, and supposing the working day to consist of 14 hours, 56 trains can be started in each direction, or 2520 tons, making a total of 5000 tons per day. The fixed engine to perform this duty will be 110 horses' power, equivalent to 22 horses' power per mile in each direction.

	Number of passengers.	Total load.		Maxim'm speed in ms. pr. hr.	Vacu'm in inches of mercury.
		tons.	cwt.		
June 11, 1840	23	8	0	$22\frac{1}{2}$	18
	23	8	0	$22\frac{1}{2}$	16
	15	7	10	20	19
	21	7	18	$22\frac{1}{2}$	19
	44	9	10	$22\frac{1}{2}$	20
	58	10	7	$22\frac{1}{2}$	19
	57	10	6	18	19
	25	5	9	30	$18\frac{1}{4}$
	75	11	10	$22\frac{1}{2}$	17
	24	8	2	$22\frac{1}{2}$	15
	13	4	12	30	16
	9	7	2	$22\frac{1}{2}$	$16\frac{1}{2}$
June 29, 1840	28	8	2	30	
	28	5	13	30	
	28	5	13	36	
July 24, 1840	21	7	18	30	22
	15	4	15	30	22
	8	4	6	30	23
	15	5	0	30	$21\frac{1}{2}$
Aug. 8, 1840	16	5	1	30	21
	18 and ballast	13	10	18	$20\frac{1}{2}$
	18	5	4	30	$20\frac{1}{2}$
Aug. 10, 1840	15	5	0	30	20
	17 and ballast	13	10	20	22
	10	4	13	30	22
Aug. 11, 1840	28	5	17	30	$20\frac{1}{2}$
	25	5	13	30	20
	14	5	0	30	20
Sept. 24, 1840	23	5	10	36	
Nov. 6, 1840	17	5	3	36	21
	16	5	0	45	$23\frac{1}{2}$
Dec. 9, 1840	11	4	14	45	23
Dec. 15, 1840	15	5	0	36	$22\frac{1}{2}$
Jan. 6, 1841	10	4	13	36	$22\frac{1}{2}$
Feb. 19, 1841	8	4	11	45	$23\frac{1}{2}$

By reference to the dates of this table it will be seen that the workings of the system are equally perfect during all seasons; through the height of

summer, and in the severest winter that we have known for many years: in no single instance during the whole time has any derangement of the machinery taken place, to prevent, or even to delay for one minute, the starting of the trains. The main pipe and valve have considerably improved by working; the composition for sealing the valve has become so much more firmly bedded in its place, that while in June last we were only able to obtain a vacuum equal to a column of mercury 19 to 20 inches high, we now obtain from 22 to 24 inches, and occasionally 25. The speed, originally from 20 to 30 miles per hour, now ranges from 30 to 45. The whole attendance the valve and main received during this period was that of a single laborer for about one hour every week: the composition now in the valve-groove has never been changed; and 56 lbs. weight only has been added to supply the waste: the cost of this composition, which consists of wax and tallow, is 1*s.* per lb.

We have now procured data from which the economy and advantage of this system can be arrived at with certainty.

It is true that we have heard many objections made; and as these objections, if tenable, would involve the principle of the invention, we cannot do better than notice and comment on them here. We have been told, 1st. That our experiments do not prove the applicability of the system to an extended line of road.

2d. That the number of stationary steam engines and establishments required on this system would be an objection, in point of expense, and liability to accident.

3d. That an accident occurring at one of these stations, or anywhere along the pipes, would interrupt the traffic on the whole line; and so strenuously has this objection been urged, that we have heard it asserted that a hole the size of a pin's head, in the sealing composition, would prevent the action of the invention, and thus the traffic might be stopped for a whole day while making fruitless search to discover it.

In answer to the first objection we would say, in every case where a train has been started the pipe has been first exhausted to 18 inches of mercury or upwards: the time of performing this operation is about one minute, and from the barometric gauges fixed at both ends of the pipe the vacuum is ascertained to be formed to an equal extent throughout the whole length without any appreciable difference of time. The pipe laid down is 9 inches diameter, and half a mile long, and a pressure equal to a column of mercury 18 inches high is obtained in one minute by an air-pump 37½ inches diameter, moving through 165 feet per minute. Now it is obvious that if the transverse section of the pipe be increased to any extent, and the area of the air-pump *proportionately* increased, the result will remain unaltered,—*i. e.* half a mile of pipe will be exhausted in one minute; and supposing the air-pump has to exhaust 3 miles, it will perform the operation in 6 minutes; it is also obvious that if the area of the air-pump be increased in a greater proportion than that of the pipe, the exhaustion will be performed more rapidly, or *vice versa.* These results are matters of absolute certainty, as convincingly clear, as that the power of a steam engine must be regulated by the area of the piston on which the steam acts. No person of scientific attainments will for one moment doubt, that if a steam engine were made with a cylinder twice the area of the *largest* cylinder ever set to work, the power obtained would be in proportion to the increased area: and so with the air-pumps before alluded to; the excess of work is immediately arrived at that an air-pump six feet 3 inches diameter will perform over another of 3 feet 1½ inch diameter, the speed of the pistons being the same in both in-

stances. So plain and self-evident is this result, that we believe the most sceptical will admit it to be correct; and this being granted, the applicability of the system to a line of any length must follow; for whatever the length of railroad be, whether 3 or 30, or 300 miles, no different effects have to be produced. The working a road 30 miles long would be the same thing as working 10 roads each 3 miles long. Every 3 miles an engine and air-pump is fixed, which exhausts its own portion of pipe before the train arrives; thus, as the train advances it receives power from each succeeding engine in turn, and without any stoppage, unless required, until it arrives at its final destination, and the air-pumps continuing to work, after the train has passed, on the section they act upon, re-exhaust it in readiness for the next.

The second objection, as to the complexity and outlay attendant on a number of fixed engines, may perhaps be better answered by taking a review of the number and expense of these engines and the duty they are required to perform. On a line 30 miles long, supposing the average distance between the engines to be three miles, there would be 10 engines and air-pumps with their engine houses; and if the railroad were appointed for transporting 5000 tons per day over the whole distance, (considerably more than double the amount carried daily on any railroad in England,) the expense of one of these stationary engine establishments would cost complete £4200, which, multiplied by 10, will give £42,000—total cost on the whole line. But it is a fact which probably must have escaped the notice of those urging this expense as a drawback to the atmospheric system, if they were ever acquainted with it, that to perform a traffic of only 1700 tons per day upwards of one locomotive engine per mile is necessary; and as each locomotive costs £1500, the total capital required for locomotive power on a railroad 30 miles in length would be £45,000; in first cost, therefore, there would be a saving of £3000 in favor of the stationary power;* but this is far from being the most important saving. Every mill owner in Lancashire and Yorkshire, and any person connected with mining operations, will readily admit that his outlay being once incurred for a steam engine to drive his machinery or drain his mine, and his engine being once fixed on *terra firma*, its deterioration, uncertainty of action, or annual expense of maintenance, is not a source of annoyance or anxiety to him. Five per cent. per annum on the cost will more than cover all repairs necessary to be performed to it, and all oil, hemp and tallow used in working it. It is the exception, and not the rule, if a stationary engine once fixed meet with a derangement to render a stoppage necessary.

The annual expenses will be for repairs at 5 per cent. on £42,000	£2,100
For coal for these engines (when transporting 2000 tons per day,)	
6420 tons per year, at 20s. per ton - - - - - - -	6420
Wages to engine-men and stokers - - - - - - - - -	1800
	£10,320

The Liverpool and Manchester railway is 30 miles long, and is the only railway that transports as much as 1700 tons per day over its whole distance; and the annual expense of its locomotive department, including coke, is about £50,000 a year.

Need we make any further comment, when the annual expense of power for the atmospheric system is £10,320, and for performing the same traffic on the locomotive system upwards of £50,000 is found necessary? Great

* This saving is in engines only, but it should be recollected that there are many other items, and by reference to the comparative expense of the two systems (page 238, R. R. J.,) it will be seen that the total outlay on the locomotive system is £37,600 per mile, and on the atmospheric £15,120.

as the pecuniary advantages have been shown to be, we must not forget to correct the third objection; viz., the erroneous opinion that the system is faulty because an accident occurring at one of these stations would interrupt the traffic on the whole line. *Prima facie*, this argument is correct, but we have already shown how small the chance of accident is to a stationary steam engine; hundreds are employed day and night without interruption, draining mines; if any derangement in their action were to take place, these valuable properties would be overflowed, and it would require no difficulty to point out many establishments where engines have been in action for years together.* But to make assurance doubly sure, a pair of engines and a pair of air-pumps, each of half the requisite power, may be fixed at each station: should anything cause one engine and pump to stop, the traffic would not be interrupted; the only delay would be the retardation of the train while passing over that section of pipe where only half the power was in action, and until the cause of the stoppage were removed the trains would be some five or six minutes more than usual performing the journey.

The next objection we have to meet is the interruption to the traffic from some derangement in the pipe. This comprehends, 1st, an accident to the pipe itself; and 2d, from the composition not being effectually sealed.

An accident to the pipe can only occur from breakage, and unless designedly perpetrated, could never happen at all. But for the sake of argument we will suppose a pipe has been broken—no matter how; the time of removing it and replacing it with another would be considerably less than the time now necessary to clear off the fragments of a broken engine and train after a collision; and supposing a length of valve to require replacing, it could be done in less time than replacing a rail when torn up by an engine running off the line.

If, instead of one, there were one hundred places along the pipe where the heater had imperfectly performed its functions, the admission of atmospheric air through the composition in these places would only reduce the column of mercury a few inches: no stoppage or interruption of the traffic could possibly occur from this cause, and by comparing the quantity of air pumped out each stroke of the pump, with the quantity that will leak in at each imperfectly sealed spot, any such erroneous idea will be removed. Perhaps on this head, an appeal to experience will be more satisfactory than any argument, however strong: in the whole of our workings, the column of mercury has never varied in height more than 2 inches on the same day; and as it requires eight times the number of minutes to destroy the vacuum in the pipe, when the engine is at rest, that it takes to raise it when in action, it follows that one-eighth only of the power (two horses) is all that is employed to overcome leakage. Perhaps the necessity of stopping the traffic of a line in the event of an accident until the damage is replaced or the obstacle cleared away, should be regarded upon all railways as a peculiar advantage: by this necessity all chance of "running into" is avoided, and where stationary power is employed the difficulties of commuication which a locomotive line has to contend with are overcome. By means of an electric telegraph, every engine station along 100 miles of road may be communicated with in half a minute, and thus the traffic may be suspended and resumed at pleasure.

On examining the facts we have collected, it will be seen that the atmospheric system is grounded on sound principles, and free from many objec-

* At Rock's Mine, Cornwall, an engine has worked day and night without intermission for 3 1-2 years. At the East London water works, a pair of engines, called "the twins," have worked 11 years, with scarcely one hour's rest day or night.

tions that the present railways have to contend with: and a very casual reference to these defects will prove the necessity of substituting an improved system to meet the wants of the public, when this means of travelling becomes fully developed and understood.

The general benefits that railway travelling has conferred, are admitted by all; their introduction has given a new stimulus to industry, and presented increased facilities for the merchant, manufacturer and agriculturist, by bringing the remotest parts of the kingdom within a days journey,—thus enabling goods and agricultural produce to be conveyed to distant towns, for which the previous mode of transport was unequal; indeed, the numerous advantages of railways have been fully appreciated by the public, who have not hesitated to embark immense sums of money to construct them between most of the principal towns.

In proportion as persons have acquired a knowledge of the commercial benefits that arise from this improved system of travelling, and have felt the advantages of it practically, their distaste for the old mode of conveyance has increased; and if railway communication were attainable at a cost at all approximating to that previously employed, it would very shortly become universal throughout the empire. But the general adoption of the railway system followed its introduction so speedily, that many roads were half finished before their expenses could be ascertained; each town capable of raising sufficient capital to connect itself with the metropolis did so immediately,—more eager to be on a par with its neighbor, than considerate of the expense it was about to incur. Fortunately these increased facilities in many cases created a traffic which compensated for the outlay that was found necessary to form and work these roads; and as there is now so large a portion of capital sunk in this description of property, and a moral certainty that a greater number of railways will be made in the next ten years than have been made and partially completed in the last,* any invention tending to facilitate their formation, or to reduce their cost, is a matter of the greatest national and commercial importance: and if by such an invention the speed of travelling can be further increased, the danger of accidents diminished, and the expense of transporting goods reduced to as low a rate as by canals, the traffic, and, as a natural consequence, the remuneration to the proprietors, will be proportionably augmented.

Our object is to point out, that these results will follow the adoption of the atmospheric system of working, and we think it will be admitted that we have fully borne out and justified this idea, when we have taken a review of the nature of the power and the experience already obtained on the one hand, and of the drawbacks under which the present systnm labors on the other. We will first notice the principal defects in railways worked by locomotive power. These are the expenses consequent upon their formation and working, in addition to the impossibility of obtaining a speed beyond 25 miles an hour, without incurring a more than proportionate additional expense. For an engine that would draw 61·29 tons on a level at the rate of 25 miles an hour, would if required to travel 30 miles an hour, only be able to draw 29·66 tons, or, for the additional 5 miles in speed, a loss of more than one-half in power. These evils arise from the following causes.

First, from the necessity of making the roads comparatively level, owing to the nature of the power employed. The whole power of the locomotive engine is not available to impel the train because it has to drag itself and

* In England alone, since 1831, upwards of 2000 miles of railway have been completed, or are in progress of completion.

tender. Thus a great portion of its power is consumed even on a level; but that loss of power is greatly augmented when contending with the slightest ascent.

The extent of this defect will be more clearly apparent by an example:

Supposing a locomotive engine to possess a gross tractive force of 1700 lbs., and its weight including tender, to be 20 tons, (this is the actual weight and tractive force of the best locomotive engines in general use when travelling at a mean rate of 20 miles per hour,) and as 14 lbs. per ton is required to attain this velocity on a level road, 280 lbs. will be consumed to impel the engine and tender, leaving 1420 lbs. available for the train. This, at 14 lbs. per ton, will draw 101 tons on a level road. We will now place the same train on an inclined plane rising 1 in 50. The power required to draw a ton at the same speed is then increased from 14 lbs. to 59 lbs., or nearly 4¼ times as much as on a level: therefore the engine and tender weighing 20 tons will consume 1180 lbs. instead of 280 lbs., and will leave but 520 lbs. available for the train, instead of 1420 lbs.; but as the train now needs 5959 lbs. to enable it to ascend, 11½ locomotives, each possessing a tractive force of 1700 lbs., together 19,550 lbs., will be required to produce that available force; we thus have an absolute waste of more than two-thirds of the power employed on an ascent of 1 in 50, while on a level it is less than one-sixth. By the same calculation it will be seen, that if the activity be slightly increased, the locomotive engine will not have sufficient power to draw itself and tender, even without the train.

Secondly, by the necessity of having great weight and strength of rails and foundation consequent on the employment of locomotive engines. These engines (exclusive of tender) weigh generally from 14 to 15 tons each; and, in addition to the rigidity of road required to sustain this weight passing over it on one carriage, the motion transferred to the wheels by the engines alternately on each side, causes a continual displacement or forcing out of the rails.

The third, and perhaps the greatest evil, is the heavy expense attendant on working a railway by the ordinary method; and this item is rendered more excessive by the necessity of having a large number of extra engines in store to keep an adequate supply in working order. By reference to the half-yearly accounts of the Liverpool and Manchester railway, the annual expense for locomotive power and coke is found to be from £57,000 to £60,000 a year, nearly £2000 a mile per annum, on a traffic of about 1700 tons a day. This amount is exclusive of first cost and interest on the original stock.

The fourth evil is the large consumption of fuel in proportion to the power obtained, which arises, in part, from the great velocity in the movement of the pistons, preventing the steam from acting on them with full force; which causes a back pressure on the pistons, reducing their force in proportion to the velocity at which they move: the power of the engine is thus constantly diminished as the velocity of the train is increased. To so great an extent is the combined action of these defects felt, that when travelling at 20 miles per hour, the effective power of the engine is reduced to half that which would be obtained from the same quantity of steam generated, and fuel consumed, with a stationary engine. When travelling at 30 miles per hour it is reduced to less than one-fourth; and at a speed but little exceeding 45 miles, the power is so far destroyed that the engine will scarcely draw more than itself and tender. An additional waste of fuel, to an immense extent, is also occasioned by the loss of power (as already shown) on inclined planes. And, lastly, the chances of accident from collision, run-

ning off the rail, bursting of boilers; effects, which have been too severely felt during the past six months.

From the foregoing remarks it will appear that the evils of the present system are entirely attributable to the use of locomotive power, and the remedy must be sought for in the employment of stationary power in its stead: the means by which this can be effected without diminishing the accommodation and advantages at present given to the public, are next to be considered; and it is confidently expected that in the following summary will be found, not only remedies for all existing evils, but also many important advantages, both in speed and safety, which cannot possibly be obtained by the above named system.

1st. The loss of power occasioned by the locomotive engines having to draw their own weight is entirely avoided, and steep hills may be ascended with no more additional power than that actually due to the acclivity, as there is no weight except the train.

There is no other known power which can be applied to locomotion without carrying considerable weight and friction with it. The ill effects of locomotive engines have been already pointed out, and the same disadvantages exist in the application of ropes, which must be drawn along with the train, and become an increased incumbrance on inclined planes. The defects of ropes in other respects are too generally known to need comment.

2d. The weight of the rails and chairs on the new system may be less by one-third than where locomotive engines are employed, as the carriages of the train will be too light to injure them. The annual charge of maintenance of way will, from the same cause, be reduced to a considerable extent.

3d. The wear and tear of locomotive, compared with stationary engines, is as 18 to 1.

4th. By the new system the full power of the engines is always obtained: and on an incline the additional quantity of fuel consumed in ascending will be saved in descending, as the trains run down by their own gravity. The expense of fuel will be further decreased, as the expense of using coal is only half that of coke.

On the new system the velocity depends entirely upon the velocity with which the air is withdrawn from the pipe; therefore, by simply increasing the air pump, any speed may be attained; and with a fixed quantity of traffic per diem, no considerable increase in the fuel consumed or any other expense is incurred for improved speed, further than the small additional power required to overcome the increased atmospheric resistance. An actual saving in the first cost of a railway constructed for high velocities may be effected, because, by performing the journey in less time, a greater number of trains may be despatched each day, and their weight diminished; therefore the piston, having less to draw, may be smaller in diameter. The cost of the pipe (which forms the largest item in the first cost of this railway) will thus be reduced in nearly the same proportion as the speed is increased.

Besides these advantages, this system possesses others of still more importance to the public. *No collision between trains can take place*, for as the power cannot be applied to more than one piston at a time in the same section of pipe, the trains must ever be the length of a section apart from each other; and if from any cause a train should be stopped in the middle of a section, the train which follows it will be obliged to stop also at the entrance of the pipe, as there will be no power to propel it until the first train is out. It is also impossible for two trains to run in opposite directions on the same line, as the power is only applied at one end of each section.

A train cannot get off the rail, as the leading carriage is firmly attached to the piston, which travels *in* the pipe *between* the rails, and the luggage and carriages cannot be burnt, as no engines travel with the trains.

We now come to the comparative cost of the two systems.

1st. The necessity of having the railway comparatively level causes the present enormous outlay for earth work, viaducts and tunnelling, and increases the cost of land, not only by lengthening the line to save cutting and embankment, but by the quantity wasted on each side of the road wherever such work is required. Thus, if an embankment or cutting has to be made of 30 feet, at least 60 feet of land must be covered on each side of the railway in order to obtain sufficient slope, making a width of 120 feet, besides the road, except where they occur in very favorable ground. The comparative expense of this item between the two systems can be ascertained by referring to the average cost of forming a turnpike road and that of the principal railways now in operation.

Since it is not necessary to make detours to avoid steep gradients, the direction of the road in a straight line may be more nearly preserved.

LOCOMOTIVE SYSTEM.	Per mile.
Taking five of the principal railroads as the basis of our calculation, their average expense of formation has exceeded* - - - -	£36,000
And the original stock of locomotives, - - -	1,600
	37,600

ATMOSPHERIC SYSTEM.	Per mile.
The average expense of forming a turnpike road throughout England has been £3000 per mile, but for our road say -	4,000
Allow extra for road bridges, - - - - -	2,000
Rails, chairs, sleepers and laying down, - -	2,500
Main pipe and apparatus complete (on a scale for transporting 360 tons per hour, or 5000 tons per day of fourteen hours, on a road with gradients of 1 in 100,) - - - - -	5,200
Fixed engines, air pumps and engine houses, - -	1,400
Travelling pistons, - - - - -	20
	15,120
Saving per mile in forming and furnishing on the atmospheric system,	22,480
	37,600

Annual expenses of working per mile, when conveying two thousand tons per day. (This is beyond the average quantity conveyed on the Liverpool and Manchester railroad.)

LOCOMOTIVE SYSTEM.	Per mile.
5 per cent. interest on capital invested, £37,600, - - - -	1,880
Maintenance of way. - - - - - -	450
Locomotive department, including coke, - - -	1,800
	4,130

ATMOSPHERIC SYSTEM.	Per mile.
5 per cent. interest on capital invested, viz., £15,120, - -	756
Maintenance of way, and attendance on mains, - - -	300
Wear and tear of fixed engines, 5 per cent of cost, - -	70
Coal, 0·75 lb. per ton per mile, 214 tons, at 20s. - - -	214
Wages to engine men and stokers, - - -	60
Wages to train conductors. - - - -	26
Renewal of travelling apparatus and composition, - -	50
Sundries, - - - - - - -	150
	1,626
Annual saving per mile on the atmospheric system, - -	2,504
	4,130

Total expenses per ton per mile on the locomotive system, - -	1·54d.
Total expenses per ton per mile on the atmospheric system, - -	0·064

Exclusive of carriages and management, which may be taken as the same on both systems.

* Our calculations are founded on the reports of different companies whose railways are complete or in a forward state.

In the comparison which we have instituted between the locomotive and the atmospheric systems, we have not dwelt particularly on many important defects of the locomotive system, but have only noticed them with a view to point out their existence, and to show that the very nature of the system we are advocating, prevents the possibility of their being found in it. We do not think, however, that we should do justice to ourselves if we were not to notice more fully some of the worst of these evils, with the view of ascertaining to what they are attributable, and what hope exists of remedying them. We have no wish, nor unfortunately have we any occasion, to exaggerate the dangers of steam travelling. Not a newspaper but teems with arguments the most cogent, the most appalling, in favor of a change of system. We may be told that these arguments have been listened to; that the attention of the legislature has been called to the subject, and that consequently steps will be taken so as to entirely prevent the recurrence of the deplorable sacrifices of human life. We answer, that it is impossible. The fault is in the system; and no legislative enactments, however stringent, can remedy it. We have no need of assertion to prove this position. The report of the Liverpool and Manchester railway directors, and adopted by the general meeting of railway proprietors, at Birmingham, on the best means of preventing accidents on the lines, has just been published, and we desire no other arguments to support our views than the opinions put forth by these directors, who must be admitted, from their great experience, to be competent judges of the question, and whose interest is too deeply concerned to allow them to exaggerate the evils they comment upon. the following is the substance of their report.

"In considering the subject of the various accidents which have recently taken place on different railways, and the different circumstances connected with each accident, it appears that they are attributable to one or more of the following causes:

"1st. The want or insufficiency of signal lights, giving warning of danger.

"2d. Neglect on the part of enginemen of such signals when given, comprehending a culpable want of care and vigilance in not keeping a good lood-out; and,

"3d. The difficulty of stopping a train when danger is perceived near at hand."

With respect to the first cause the committee are of opinion, "that the printed rules and regulations of this company, which have been brought under the consideration of many other companies, and, as your committee believe, constitute the basis and tenor of their respective regulations, are, on the whole, well calculated to answer the purposes intended. One modification seems desirable, viz: that the red light or the red flag should, in all cases, and under all circumstances, be viewed as a warning against danger."

As to the second point; "the committee can only recommend great care in the selection of active steady men in the first instance. Good wages, and a considerate regard to their comforts so long as they do their duty; accompanied by the strictest discipline, and by uniformly putting in force the provisions of Lord Seymour's act in cases of any neglect of duty or disobedience of orders, hazarding the safety of life or property, although no loss of either should take place."

"With respect to the third point under review, the difficulty of promptly stopping trains when danger is perceived, the most efficient means hitherto employed are immediately to reverse the engine, and put on the tender break. Great care should be taken by the engineers that the reversing gear is of

the most improved construction, not liable to get out of order, and which cannot fail to act when the reversing lever is applied. * * With regard to the numerous proposals of improvements and schemes for the prevention of accidents by mechanical means, if that unceasing vigilance which cannot be too strongly insisted upon on the part of the engine driver should be at any time relaxed, those who have not been long conversant with the practical working of a railway can hardly be aware how many of them have been long since, and under various forms, already tried, and found to be attended with risks and inconveniences more than compensating for any supposed advantage."

The committee strongly deprecate the idea of relieving the engineman from "the responsible charge of his engine" by appointing a "conductor of a higher standing and superior acquirements, whose special business it should be to look out, and under whose orders the engineman should act.

"By introducing another man on the engine you have another pair of eyes to *look out;* but this advantage, if it be one, might be more than countervailed by the divided authority and responsibility which must inevitably take place.

"Jealousy and disunion, it is to be feared, would frequently arise. These would be destructive of confidence in their own resources to the men themselves, and fraught with danger to the whole train. As to the necessity for superior acquirements or professional skill, there is no evidence of a single accident having occurred owing to the want of these qualifications. The desiderata are *constant vigilance* and *presence of mind* in emergencies; and your committee are of opinion that no man, however professionally competent, ought to be trusted with the charge of an engine till he has served an apprenticeship to the business, and has thus become familiar with the rapidity of the locomotive engine and its consequent excitement, *with its severe exposure to the weather*, with the customs and practice of railway operations, and with all the contingencies of locomotive transit regarding police regulations, signals, etc."

Such are the only means recommended by the Liverpool and Manchester railway committee, with a view to get rid of the dangers attendant on this method of travelling; and we really believe that these gentlemen have suggested all that can be done; and if all railway accidents, or the greater number of them, were attributable to carelessness and neglect on the part of the engine drivers, their suggestion would go far to remedy the evil. But here we contend they are greatly mistaken; the fault is in the system, not in the men. It is quite true that the evidence produced at many of the inquests puts beyond doubt the fact, that the necessary signals have on those occasions been made and must have been seen; yet no attention appears to have been paid, and the most disastrous consequences have been the inevitable result. But does it follow that this inattention on the part of the conductor has been the result of *wilful* neglect? Can it be for a moment believed that any man would thus rush headlong into danger, to the almost certain destruction of his own life, and the imminent hazard of those committed to his care? Common sense repudiates the thought. Nothing short of madness could lead to such gross acts of crime and folly. Let us next consider the circumstances under which these accidents occur, and it will be readily seen that they may be accounted for much more satisfactorily. Many alternatives must be rejected before having recourse to the insanity of the engine drivers for an explanation. It will be seen that the question to be discussed is not, have the conductors the *will* to avert the calamities, but have they the POWER?—not whether we are to consider them as suicidal maniacs, but as

the slaughtered victims of a murderous system. Let the impartial reader judge.

Suppose our engine director fully understands the construction and management of his engine; suppose we can answer for his discretion, that he never gets intoxicated, never gets fatigued, never falls asleep while on duty, never leaves his engine while on the line, never "sits down on the seat;"* suppose him uninfluenced by the "excitement of rapid travelling,"† or by the "severe exposure to the weather."‡ Let us suppose that he can readily attend to the working of his engine, and yet keep a good lookout ahead; that he retains his vision perfect under all circumstances; that it is unimpaired by moving rapidly through the air, and is not affected by the clouds of ashes from the chimney. Let us suppose, moreover, that the atmosphere is always clear, that fogs never occur, or that they never prevent him distinguishing the color of a flag or lamp; and, lastly, let us suppose that no curves exist on the line, and that he is consequently enabled to see the signal half a mile ahead of him. Now what is the time, under all these favorable circumstances, allowed to the conductor by the usual speed, to shut off the steam, give the signal for the breaks to be applied, or, if necessary, reverse his engine? *One minute!* But in addition to the above absurd suppositions, we have presumed that the accident by which a train has been stopped has taken place at a station, and that the danger is consequently known; we have presumed that, knowing this danger, the company's servants have hoisted the red flag or lamp. But trains much more frequently break down between stations, where they cannot be expected to be provided with signals: we frequently hear of trains getting on the wrong line and meeting each other. How are they in such cases to be apprised of their danger? If they are enabled to see each other at half a mile, and recognize their dangerous position, yet but *half a minute* must elapse before they come into collision if unchecked? Is it possible that this short space of time can be sufficient for the two engine drivers to think, act, and give their directions for others to act? And if so, can we be certain that the machinery by which the engines are stopped is in proper order to obey these actions of its director? It may be of "the most approved construction," and may have been perfect on commencing the journey; but does it follow that it is so at this particular moment? It is well known that the cost of repairing locomotive engines is about 50 per cent. of the first cost; is the reversing gear, are the valves, breaks, the machinery, in short, now required to act, never among these expensive repairs? Or are we to believe that the accidents by which they are deranged always occur at the stations? No answer is required to these questions. No one, we think, will presume to assert that these parts are excepted from the fatalities which occur to the rest, or that they take place while at rest. The precautions strongly insisted upon in the report relative to this machinery prove that they have been called for. And now we would ask, are we justified in attributing these melancholy occurrences to the folly of the engine driver? Is it not sufficient to see his mutilated corpse stretched before us, but we must accuse him of *felo de se*, and refuse his remains a christian burial, when an accident to the machinery (of the occurrence of which the report indirectly admits the possibility) would at once excuse him? Charity, pity, all the better feelings of humanity, answer in the affirmative.

It will be readily seen that the suppositions we have made in order to give every possible advantage to this system are absurd, for we have assumed

* One of the charges made against the unfortunate Simpson on the inquest.

† Vide report. ‡ Ibid.

humanity to be perfect, materials indestructible, the atmosphere invariable, curved lines straight; yet this is not sufficient: we must still presume that actions require no time for their performance, and that matter is deprived of its *vis inertiæ!* Had we drawn any inference from the facts that sad experience has afforded us to judge from, we should have concluded the danger to be entirely referable to the use of locomotives, huge masses moving at a great and *varying* velocity, and over which the conductor has comparatively no control. To render railway travelling safe, (a method of travelling now so essential to the commercial prosperity of this country,) we must begin by rejecting the locomotive, and substituting in its stead stationary power.

If we have shown, as we hope we have, dispassionately and fairly, that so large a balance of safety is due to the atmospheric system, the large saving of human life and suffering that would result from its adoption ought to be one of its best advocates for public patronage; and in the same proportion that it restored public confidence and appetite for railway travelling, would it benefit the directors and proprietors. Every fatal accident, on whichever railway it has occurred, has been followed by a sensible reduction in the traffic; and this can be a matter of no surprise, when it is recollected that the present traffic possessed by all railways was actually formed by the increased facilities and inducements they held out to travellers over turnpike roads; remove these facilities, and the increased traffic will vanish. No railroad in existence could pay its expenses carrying only such passengers as are actually obliged to travel, and therefore the best policy of railway directors is to induce the public to use their lines by affording them the fullest and best accommodation as regards safety, speed, cheap fares and agreeable travelling. That railway which provides best for the wants and wishes of the public will, and very properly so, become the most patronised; and it is scarcely too much to assert that a very large portion of business will spring up and locate itself along such lines, while others which may at present possess a large traffic will lose what they found to their hand, if, neglecting this course, they lull themselves into the mistaken notion that the monopoly they possess, not the convenience they afford, will guarantee them an equal amount of business.

The first grand object in railway undertakings is to render them a perfectly secure mode of transit—a conveyance by which the most timid may travel without hesitation, without a thought of fear, and of course without an example of ill, arising from the badness of their workings, to refer to: these great works, destined as they are to effect much good to all classes of society, will never be, nor indeed deserve to be, looked upon as a permanent benefit until they have arrived at this point. Precisely as a country flourishes under a well regulated system of police and justice, where the liberty and right of the subject are respected, so will railways flourish as human life in their keeping becomes secure. The high roads of England became more travelled over as the robbers that infested them fell into the hands of justice; and it is a matter of small importance to a person contemplating a journey whether he have to fear falling a prey to the assassin's knife, or losing his life from the collision of two railway trains. The possibility of either would equally prevent the timid from travelling, and the courageous from travelling more than necessity required.

To render the railway system perfectly secure is, then, the first object, and to this end should those who have its prosperity at heart look well. Humanity dictates it, and interest prompts it; and what greater inducements, we would ask, need be urged?

Perhaps the next point, after having arrived at that degree of security required to satisfy the public, is to obtain that system of working which is the most economical. A large portion of the British commercial public have, with that enterprize which characterizes all their actions, embarked large sums of money in establishing railway communications between most of the principal towns in the kingdom. They saw the advantages that were certain to result from such an improved communication, but they did not know, indeed it would have been too much to have expected from them the expense of making and maintaining this communication. They only knew what their engineers told them. Their engineers' estimates in most cases were considerably less than was found necessary for the work, and this, added to the increased annual expense of working (above that originially contemplated when most of the present lines were projected,) has placed these undertakings in a very questionable light as commercial speculations and permanent investments. If we show this to be the present position of most railways, which we intend doing by reference to their own accounts, we wish it to be understood that we do not from this circumstance draw a conclusion that they cannot be made a lucrative investment. On the contrary, we are of opinion that they can: we think it has been clearly shown that all their difficulties have arisen and are perpetuated by the use of an improper system of working. So long as the locomotive system is adhered to, a strict economy may in a small degree lessen the expenses, but no material improvement can be hoped or obtained. To strike at the root of the evil, the system must be abolished; anything short of this will not be productive of benefits on a sufficiently extensive scale to enable railways to maintain their present position, and yield a return for the millions they have cost. A better instance of this fact can scarcely be needed than an inspection of the receipts and expenditure of those railways already in operation. From the official weekly returns in the "Railway Times," we perceive *seventeen* railways are in operation the whole of their length, and out of the whole number only *three* are earning sufficient to pay their subscribers more than common interest for their money. Of the remaining fourteen, six are not taking as much for their *gross* receipts as the interest of their capital embarked, *independent* of working expenses; and the receipts on the remaining *eight*, after deducting the working expenses, do not leave £5 per cent. dividend for their subscribers.

Fifty millions sterling have been embarked in railway speculations, and seventeen lines have come into full working activity, of which number only *three* can show a return beyond common interest to the subscribers: it well behoves capitalists to ascertain the cause of their disappointments, and to seek to recover some of the golden harvests they were led to expect, and which have melted away before their eyes like ice in the rays of the sun. Anything short of perfect indifference to their own interest will force on them the conclusion that they must no longer shut out the idea of improving, and listen only to the counsel and advice of those at present in their confidence, whose interests are served by maintaining things as they now are, and by clinging to preconceptions and prejudices as part and parcel of their existence. When looking over the half yearly accounts of a railway worked by locomotive power, common sense and observation cannot fail to lead to the conclusion, that a very large portion of what would be profits is absorbed by the nature of the power applied; but although a cursory notice of the accounts would prompt this conclusion, few would imagine, without giving the matter very close attention, how great this portion is. Some idea of it may be drawn from the following facts. Each train on railways

is drawn by an engine, the average weight of which is 20 tons; therefore 20 tons carried with each train is perfectly useless. On the London and Birmingham railway the lowest charge for goods is £2 per ton for the whole 112 miles. Supposing, for the sake of argument, the expense of maintaining and working the locomotive department to remain unaltered, but the engines to weigh nothing; it is clear that the company would be able to transport 20 tons more with each train for the same cost, or 15 tons of profitable merchandize, after deducting one-fourth for the wagons, which at £2 per ton would add to their revenue £30 per journey, or, with their present number of trains, (12 each way daily)—£306,000 a year. No doubt this fact will take many railway proprietors by surprise, who by a natural course of reasoning will immediately seek to discover by what means so large an amount, at present wasted, can be made to find its way into their pockets. The means are obvious; the waste is occasioned by transporting useless weight; remove the useless weight, and the objection ceases of itself. Before the introduction of the atmospheric system, it was hopeless, by any known mechanical means, to effect this: every previous application of power carried considerable useless weight with it. The atmospheric is entirely free from this objection; and it was mainly from a knowledge of the benefits that must result from this source that we have labored so incessantly (and happily with such success) to mature and bring it before the public, for their consideration and approbation.

Such would be the effect of dismissing only the *useless weight;* but add to this the other advantage possessed by the atmospheric system, and the London and Birmingham railway (notwithstanding its present large capital sunk) would be enabled *to carry passengers at* 5*s. each, and goods at* 6*s.* 3*d. per ton, the whole* 112 *miles, and share the same dividend as now.*

The calculations from which this statement is adduced are shown as follows: viz.*

		Per day.	Per year.
2500 persons at 5*s.* each, - - - -		£ 625	
5930 tons merchandize at 6*s.* 3*d.* per ton, - -		1,853	
		£2,478—	£805,360
Expenses, viz:			
Coals, 38 stations × 500 lbs. per hour × 16 hours per day = 6867 tons per year at 10*s.* per ton, - -		£ 3,434	
76 engine drivers at £100 per year, -	£7,600		
76 stokers at £50 per year, - - -	3,800		
Repairs to engines, oil and tallow, at £70 each × 38, - - - - -	2,660—	14,060	
Renewal of travelling apparatus, composition, charcoal, etc., £100 per mile × 112, - - -		11,200	
Maintenance of way and attendance to main £300 per mile,		33,600	
Police, coaching, wagons, etc., (as on locomotive lines),		80,604	
General charges, (as on locomotive lines), - -		15,400	
Parish rates, (as on locomotive lines), - -		14,400	
Add 5 per cent. interest on £1,500,000, the total amount required to furnish the atmospheric apparatus on a scale for transporting 9600 tons per day, - -		75,000—	247,698
Balance, - - - - -			£557,662

* This estimate of traffic is of course much greater than at present exists on the line, but considerably less than the reduced prices would produce; it is scarcely necessary to add, that at these rates any extent of traffic could be obtained in coals and iron alone, as it is less than a sea borne freight from the north.

	Per day.	Per year.
By reference to the last general meeting of the London and Birmingham railway company, (see "Railway Times," 13th February, 1841,) the present receipts average per year, - - - - -	£810,000	
And the present expenses, - - - - -	260,000	
Balance, - - - - - -		£550,000
The present charges are,		
For passengers, (average), - - - - -		25*s.* each.
Lowest charge for merchandize, - - - - -		40*s.* per ton.

We have already shown the expense of formation in railways to be greatly influenced by a portion of the power employed being unavailable, and that the road is levelled as a convenience for the propelling power, not the traffic conveyed. We have also shown that the destruction to the road is attributable to the weights and shocks of the engines, not of the trains; that the enormous expense of locomotive power and coke arises from the bad application of power and the artificial means employed to work engines at an unnatural speed. In other words, all the expenses have been traced home to the use of locomotive engines, which have, from the opening of railways for passenger traffic to the present day, been a source of continual annoyance and vexation; breakage after breakage has occurred, and been succeeded by increasing the weight and power of the machines; this in turn has led to the necessity of increasing the strength and stability of the rails and foundations on which they travel, and increasing the strength of the passenger carriages, to resist any shocks they may occasionally receive from their ponderous neighbor; until we have arrived at this conclusion, that on an iron railroad, where the surface is by comparison smooth and the track marked out, a carriage to convey eighteen passengers must weigh about 3 tons, while over a rough paved road an omnibus weighing only 1 ton will perform the same amount of duty. Here are facts which must at once convince every one that there are in the present system, radical defects to be weeded out: if no remedy were suggested, it might be difficult for railway companies to determine how to extricate themselves from their present position; but under existing circumstances their position is by no means a difficult one. The atmospheric railway has been tested by actual operation at the entire expense of the inventors and their friends. The public have not been asked to support it, or even encourage it, until it has been clearly proved beyond all doubt to merit confidence from its general usefulness. It has claims to notice both in a national and commercial point of view; for while it will afford the means of railway communication to second and third rate towns by the small outlay necessary for the formation and working, it will enable the proprietors of railway enterprizes already established or in course of formation, to realize that return for their capital which they so richly deserve, and which, under the present system, they so hopelessly look for.

The length of the foregoing treatise, prevents us from giving, as we promised and intended, in this number, the examination of Messrs. Gibbons, Cubit, Brunel and Stephenson, before the committee of the house of commons. We shall, however, continue the subject in our next, and at considerable length, that it may be properly understood in this country, at least as far as it can be from the experience of those who have examined, studied and tested it. In giving thus fully the views of the patentees, and those

who have experimented upon it, we have but *one* object in view, and that is to bring the matter fairly before the railroad community that it may be understood, and if found to possess advantages over the present system, adopted; but if not, then let us stand by the "*iron horse*" which has already accomplished so much.

To succeed and come into general use, it has yet to overcome a powerful opposition, not greater however, than the locomotive has already overcome; we therefore have no anxiety in relation to it, as there is likely to be a thorough and probably fair trial of it on the Epsom road, after which, *opinion* or *theory* will give place to *fact*, and the system will be either sustained or exploded; although we do not agree with the "North American" that it has already "exploded" as there are quite as good opinions in its favor,—Mr. Cubit's, Mr. Brunel's and Mr. Gibbon's—as Mr. Stephenson's against it, as we will show in our next.

GEORGIA RAILROAD AND BANIKNG COMPANY.

We are indebted to J. E. Thompson, Esq., chief engineer, for a copy of their last report, giving a statement of their progress to April last, from which we learn that the work is progressing steadily, but surely, to completion. In 1837 forty miles of this road was brought into use; in 1838 it was extended to 75 miles; in 1839 to 88 miles; in 1840 to 105 miles, and in 1841 to 147½ miles. The total receipts for passengers and freight are given as $1,233,887 00, its total expenses $528,168 00 and its net profits $705,719 00. The rates were considerably reduced last year, and the business increased nearly 33 per cent., and the net profits are nearly $10,000 greater for 1843 than for the previous year, thus showing in an eminent degree, the correctness of the policy of putting the charges at rates which will *increase*, rather than prevent or divert in other channels the business of the region through which railroads pass. It is worthy of remark, that with an increase of business of over 30 per cent. in 1843, the expenses of the road were less by $9,246 than in 1842. The net profits exceed *six per cent.* on the cost of the road, including its branches and machinery, which is certainly encouraging to those interested, to push on the work as rapidly as possible; and it encourages us to look forward, with increasing confidence to its connection with other interests and other roads, until it rests one foot on the Mississippi and the other on the gulf of Mexico, with its outlet on the Atlantic.

ENGINEER'S REPORT.

To the Hon. John P King, president of the Georgia railroad and banking company.

SIR:—I have the pleasure to communicate to you the proceedings of this department for the year ending on the 31st of March.

Active operations upon the extension were commenced between Madison and Covington about fifteen months since. From the nature of the contracts entered into, the work has necessarily progressed but slowly. Yet we have every reason to believe, that the whole of the grading and masonry then contracted for—much of it quite heavy—will be finished by the first of July

next, except probably a rock section which may not be completed until August. In consequence of the uncertainty which rested over the extension of our road, even to Covington, the wood work of the bridges, from its perishable character, was not contracted for until the general letting in November last, at which time it was thought that if immediately commenced, it could be finished as soon as the grading. The subsequent demand for labor, and consequent rise in its price, has however, materially interfered with the execution of the timber contracts, which together with the failure of the Nisbet iron works to supply the bridge irons required, has greatly retarded the progress of the work, and I fear, will prevent us from reaching Covington as early as we had desired.

As soon as practicable after the means necessary for the continuation of the road to the southeastern terminus of the State work had been obtained, the grading and bridging of the whole line was placed under contract. The work was let upon very favorable terms, but from causes already referred to, it has not progressed with that spirit which we had expected. Since the late decline in the staple of the country, labor has become more abundant, and the work is now advancing with renewed vigor. From our present prospects, it is believed that the whole line, with some immaterial exceptions will be ready by the first of February next for the reception of the superstructure. While we cannot calculate with certainty the precise time we shall reach Covington, yet we may safely place the completion of the entire road to the State terminus at not later than September, 1845.

The following is a revised estimate of the cost of the road from Madison to the southeast terminus of the Western and Atlantic railroad, a distance of 67$\frac{4}{10}$ miles.

Graduation, including culverts.

From Madison to Rutledge's, 8·8 miles,	$26,500 00	
" Rutledge's to Social Circle, 7·3 miles,	27,800 00	
" Social Circle to Covington, 10·4 miles,	87,400 00	
" Covington to Holcomb's, 10·5 miles,	51,800 00	
" Holcomb's to Stone Mountain Depot, 15·0,	43,100 00	
" Stone Mountain to Marthaville, 15·4 miles,	71,600 00—	308,200 00

Bridging.

Alcovy bridge and truss work,	1400 feet,	20,600 00	
Cornish creek bridge,	610 "	4,900 00	
Wood's mill bridge,	470 "	4,700 00	
Dried Indian creek bridge,	900 "	4,600 00	
Turkey creek bridge,	370 "	1,800 00	
Yellow river bridge and approaches,	490 "	12,800 00	
Sundry small railway and road bridges,		3,300 00—	52,700 00

Superstructure.

Mud sills for main line and turnouts,	69 miles,	20,700 00	
Cross ties "	"	28,900 00	
Wooden rail or stringers, "	"	29,800 00	
Iron (exclusive of duty) at $45 per ton,	"	185,000 00	
Cast iron chairs and washers,	"	11,000 00	
Screws, spikes and bolts,	"	19,000 00	
Laying superstructure and contingencies,	"	48,000 00—	342,400 00
Right of way, - - -		18,000 00	
Real estate to be retained for use of road, -		12,000 00	
Engineering, etc., - - -		33,000 00	
Depots, wells, pumps, tanks and division houses,		18,000 00—	81,000 00
Total cost of road,			$784,300 00

Equal to $11,366 per mile for the length of single road, or $11,636 per mile for the distance between Madison and Marthaville; which, if the whole had been executed at the present low cash rates, could have been done for about $1000 per mile less. * * *

The receipts of the road for this year, have exceeded those of last year only $69 50, while the gross tonnage has been increased fully 33 per cent. On the down freight, the receipts have fallen off $6,173 80, and the passage money has increased $6,290 08—the up freight remaining nearly stationary. It will be recollected, however, that we received last year about $12,000 for the transportation of iron, spikes, etc., for the Western and Atlantic railroad, which should not be counted in the general business of the country. By deducting this amount from the receipts of that year, we have the increase of the receipts of this year, about equal to those of last year over the year previous.

The reduction in our rates was probably greater than succeeding circumstances have justified; especially as they have not been met by corresponding concessions on the part of our neighbors on the other side of the Savannah, except upon such articles as they are competitors with the steamboats for. But as there has been no diminution in our receipts, and notwithstanding the increased tonnage transported, the expenses of the road have fallen short of those of last year. We are not disposed, from these causes, as well as a disinclination to frequent changes, to make any material variation in our tariff.

Having failed in our efforts to form a satisfactory ticket at a reduced rate, for the travel going through from Baltimore to Montgomery, we have been content to confine ourselves to a ticket from Montgomery to Charleston—between which points passengers are now carried in less than two and a half days, for $26 50, by railroad and stages.

We have also, in conformity with a resolution of the board, carried out the suggestion referred to in my report of last year, in relation to planters accompanying their produce to market at a reduced rate. The system, as far as we can judge of its effects, seems to have operated alike beneficial to the company and planters, and is at least worthy of a longer trial.

The business of the road, and the expenses incurred in working it, during the year ending on the 31st ultimo, are shown in the following summary statement. The usual detailed statements of the several accounts, will be found among the accompanying papers.

CR.

By amount received for passengers up	$34,005 20	
" " " down	31,660 83	
" " extra trips, extra baggage, negroes, etc.	3,664 86	
" " freight up	69,661 19	
" " " down	78,400 26	
" " " between stations	388 52	
" " rents	809 66	
" " United States mail	29,246 97—	$248,096 44

DR.

For expenses of conducting transportation	$26,902 61	
" " motive power	25,838 29	
" " maintenance of way,	38,156 97	
" " " cars	9,675 45—	$100,573 32
Leaving net profit		$147,523 12

Over six per cent on the cost of the road, including the branches machinery, etc.

The expenses of the road have, for reasons given in my last annual report, fallen below those of last year. For the next year mainly from opposite causes, they will be somewhat higher.

The efficiency of our motive power has been so materially increased, that although we have had a larger tonnage than usual, and had disposed of one of our original stock of engines, we have still been able to do the business with regularity, without calling into service two of the remaining number. This improvement is mainly to be attributed to the alteration of the Tennessee, to Messrs. Baldwin and Whitney's improved freight engine, referred to in a former communication. This engine having been the first of the kind made, we had to encounter the risk of a failure in some of the details of its construction—the subsequent occurrence of which, as anticipated, prevented us from deriving any benefit from the services of the machine until last fall. We have since given it ample trial, and have become as fully satisfied with its practical performance, as we had previously been with the principles upon which it was built. As soon as we had fully tested this machine, we ordered in accordance with our original intention, a small engine of similar make, for the Athens branch, to be delivered this spring. We are informed however, by the manufacturers, that upon putting it together, its weight greatly exceeded our limits, and in consequence, we have been compelled to reject it, and wait until another can be completed.

The number of miles run by all our engines, during the year, is 153,125, of which 87,200 miles was by the regular passenger trains, on the main line and Athens branch, carrying also some freight. The net amount of freight hauled by all the trains one mile, is about 1,300,000 tons, exclusive of materials for the road. The expenses of the motive power department are $25,838 24, or 16 $\frac{8}{10}$ cents per mile run by the engines. The repairs of the engines and tenders, and the cost of fuel, are each 3 $\frac{7}{10}$ cents per mile run. The whole expense of the road is 65¾ cents per mile run by the trains. The cost of maintaining the road is, this year, $260 per mile or nearly 25 cents per mile run by the trains.

IRON REVENUE STEAMER ON LAKE ERIE.

We have been politely furnished with the following statement in relation to the iron revenue steamer on lake Erie, built by Messrs. Stillmam, Allen & Co., of this city, for the United States revenue service. Length of keel 144 feet, breadth of beam 23 feet, depth of hold 12 feet; keel 1 foot in depth of ½ inch iron; ribs or frame 4½ × ⅝ inch; plating of bottom ⅜ inch.—Rigged with three masts, having a pair of Capt. Hunter's submerged wheels. Weight of iron about 125 tons. This ship was put up in the ship house of Stillman, Allen & Co., taken down in sections of convenient size for shipment, and sent to Buffalo, where she is now rapidly going on to completion. She is one of four of the same class now building under the direction of Capt. Wm. A. Howard. The engines for this vessel are being made at the "Buffalo steam engine works," according to the direction of Capt. Hunter, but of their capacity we are not informed.

☞ Will the chief engineer of the Baltimore and Ohio railroad please answer the following enquiry?

June 26.

Mr. Editor: To decide a discussion, will you be so kind as to furnish a reply to the following query, in the next number of your Journal, or whenever it is convenient to you; or call upon a correspondent well informed of

the facts, for an answer?—What was the actual cost of the depot and car house at Baltimore? I am anxious to get a certain estimate, and your attention to this request will be considered a real favor. Respectfully your's,

A FRIEND TO INTERNAL IMPROVEMENTS.

DELAWARE BREAKWATER.

Major Bache, United States engineer, says, in his report to the secretary of war, dated October 15th, 1843,

"Since the session of 1837 and 1838, no appropriation has been made to continue the construction of the Delaware breakwater, and the last stone provided by that appropriation was deposited in 1839. * *

"The following table shows the number of days' shelter afforded to vessels by the Delaware breakwater, from the 1st of September, 1833, to the 30th of September, 1843, inclusive—omitting the periods embraced between the 1st of July and the 17th of October, 1834; and the 4th of June, 1840, and the 30th of April, 1841, (when no record was kept); and also omitting vessels carrying stone, or otherwise connected with the work.

Years.	Ships.	Brigs.	Schooners.	Sloops.	Pilot boats.	Total.	Remarks.
1833	22	178	372	167	127	866	From Sept. 1st, inclusive.
1834	48	315	667	303	411	1,744	July 1st to October 17th, inclusive, not recorded.
1835	133	569	1,719	461	644	3,526	
1836	301	1,027	2,719	620	767	5,433	
1837	227	478	2,777	629	732	4,843	
1838	165	732	3,191	765	685	5,538	
1839	165	504	3,561	734	697	5,661	
1840	172	279	1,909	308	371	3,039	To June 3d, inclusive.
1841	111	902	3,916	590	483	6,002	From May 1st, inclusive.
1842	107	1,060	5,335	802	794	8,098	
1843	84	644	3,865	962	572	6,127	To Sept. 30th, inclusive.
	1,535	6,688	30,031	6,341	6,283	50,878	

"Making a just allowance for the periods when no records were kept, it may be safely said, that from its commencement to the present time, the harbor has given sixty thousand days' shelter. According to the record for the last four years, twenty-two vessels on an average, had been lying in the harbor for each day. Sixty to seventy vessels are seen frequently lying in the harbor at the same time, and on one occasion the number of vessels reached as high as one hundred and eight. * * * *

"These works have not yet been completed to the extent of the design thus briefly described. The breakwater is in a course of construction for 862 yards, and the ice breaker for 467 yards. In other respects, the design of the harbor is necessarily incomplete. The entrances at the cape, and between the two works, are 780 yards, and 455 yards, respectively, instead of 500 yards and 350 yards, as at first contemplated. It would thus appear that on the one hand the breakwater proper is 338 yards, and the ice breaker 33 yards, less; and on the other, that the entrance towards the sea is 280 yards, and that between the works 105 yards, greater than the plan called for. In short, the lines of protection are less, and the entrances greater, by the quantities just given, than were originally designed. * *

"It is believed that no plan has been devised to correct the evils in the harbor caused by running ice. One is incidentally alluded to in the annual

report of 1836, and the imperfection of it is clearly demonstrated. Any structure on the course of the current would not afford protection against running ice; and one of stone across the current would, by impeding it, create shoals that would injure if not destroy the harbor. The great desideratum is, to be able to obstruct the ice without obstructing the free course of the current. In order to accomplish this result, the application of the iron screw pile has been suggested in former reports These piles, it is conceived, may be so combined as to constitute a complete barrier against the passage of the floating ice, at the same time that the current is allowed to flow in its accustomed course, and with the same velocity. It is, in all respects, worthy of consideration, whether a fair experiment, conducted with liberal means, ought not to be made, in order to ascertain clearly whether the iron screw pile may not be successfully applied to this purpose. The result, if favorable, would constitute an epoch in the construction of ice harbors, and would lead to kindred applications of much importance. It is with a view to such an experiment, that an item for iron screw piles is included in the estimate of the operations for the next season. In using such piles in the formation of an ice harbor, they may either form a continuous work, composed of rows in quincunx order, or constitute piers at certain intervals, as may be deemed advisable, after proper investigations. Under any form of combination, the piles should be braced horizontally, by bars of iron, at low water and at the top, in order that the shock caused by the ice may be sustained, not by one pile, but by numerous contiguous piles. In adopting the work just described as a remedy for the defect in the harbor of the Delaware breakwater, arising from running ice, it should commence at the west end of the ice breaker, and extend towards the shore, on the shortest line, until the required protection is gained."

BEAR MOUNTAIN RAILROAD.

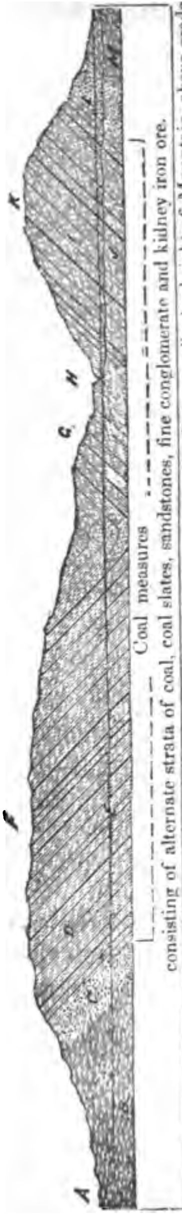
This road penetrates one of the richest and most extensive anthracite coal fields in the State. The Bear valley coal basin, which will be immediately opened by this road, comprises the southwestern termination of the great coal field surrounding the town of Pottsville. This basin is about thirteen miles in length, varying from two to three miles in breadth and the average breast of the coal veins above water level in the two mountains forming the sides of the basin, is over one thousand feet.

All the varieties of anthracite coal, red, white and grey ash, found in the Pottsville region, are found here, and the quality is in every respect of the most superior kind.

Prof. Walter R. Johnson, in his report on the Bear valley coal district, states that this coal bears a stronger analogy to that of Yniscedwyn in Wales, used in Crane's celebrated iron works, than any other anthracite coal in Pennsylvania.

Iron ore also in abundance and of excellent quality, has been found intervening the coal veins. The coal veins run lengthwise of the two mountains throughout their whole extent, and dip in each mountain under the enclosed valley, at an angle of about forty-five degrees. They are found alternating with coal slates and large strata of sand stone and conglomerate rock, interspersed with occasional layers of iron ore. The annexed dia-

gram exhibits a cross section of these mountains and the position of the coal veins.



REFERENCES.—A, entrance of tunnel; B and M, red shale; C and L, conglomerate; D, perpendicular height of Mountain, above grade line, 800 feet; E, grade line 17,424 feet per mile; F, Big Lick mountain; G, end of tunnel; H, Bear valley; I, Rausch gap; J, Rausch creek; K, Bear mountain.

The north, or Bear mountain is cut to its base by Rausch creek, forming a gap, on each side of which, all the veins can be opened; and the south or Big Lick mountain will be penetrated by the railroad tunnel directly opposite Rausch gap, thus opening all the veins in that mountain in the same manner.

By this means every coal vein in the entire region will be opened in the most advantageous manner for working. It is confidently believed that no other coal region in the world is possessed of equal advantages.

The height of the mountains above the tunnel, and above the grade line of the road in the gap, is about eight hundred feet, consequently the breast of coal in the veins outcropping at the summits of the mountains is over eleven hundred feet. The tunnel will cut across at least fifty veins of good coal varying in thickness from four to thirty feet, and besides these there are not less than thirty veins of similar thickness in Rausch gap.

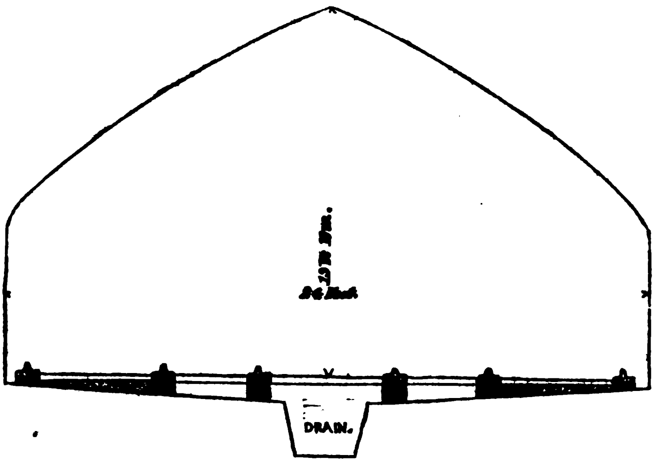
From this it will be perceived that even if the whole supply of coal for the United States, was to be obtained from this region for centuries to come, it would not be necessary to mine below water level and consequently the enormous outlays for machinery, and constant expense necessary to raise coal from below water level, will in this region be entirely avoided.

The railroad tunnel through the southern coal mountain will be about one and a half miles in length, and of sufficient width for three tracks, the centre track being intended for the use of locomotives and through trains, and the side tracks for coal cars only.

It will require about 750 lineal yards of this tunnel from the south end driven through solid rock to reach the outside coal vein, and the remaining distance will be through coal, coal slates, sandstones, conglomerate and iron ore. It is intended to drive about 800 lineal yards of this tunnel by the time the road is ready for business, leaving the remaining portion of the tunnel to be driven after the road goes into operation. The tunnel will be cut on a grade descending towards the canal at the same rate as the other portion of the road, viz. 17½ feet per mile, and when the tunnel is completed, the road will be extended on the same grade through Rausch gap.

The form and dimensions of this tunnel are shown in the following sectional drawing.

SECTION OF TUNNEL THROUGH BIG LICK MOUNTAIN.



From the termination of the road on the Pennsylvania canal at Dauphin to tide water at Havre-de-Grace is eighty miles. The canal from Dauphin to Columbia is of the same capacity as the Erie canal, capable of passing boats of from seventy-five to eighty tons burthen, and the Tide Water canal from Columbia to Havre-de-Grace is of still greater capacity. Havre-de-Grace being at the head of Chesapeake bay, the Atlantic coast can be reached from this place, more readily than from any other point where anthracite coal is shipped, unless it be Delaware city, and to this point the coal can be transported in the same boats used on the canal.

It is not the least recommendation of the Bear valley coal region, that it will have a very large home consumption, without coming into competition with the coal from any other region, and as the Bear mountain railroad will be the only means of transportation from these mines, it may perhaps escape the effects of "incendiary publications."

The coal from the Bear valley region will have the entire command of the trade south and west of the mines, including the cities of Lancaster, Baltimore, Washington, the Boroughs of Harrisburg, Columbia, York, Chambersburg, Carlisle, Hagerstown and the adjacent country, with its extensive iron and other manufacturing establishments and consequently must have a certain trade of nearly 300,000 tons per annum, before coming into competition with coal from other districts. When in addition to this we take into account its proximity to the seaboard, the favorable character of its avenues to market, and the low price at which it can be delivered in the Atlantic cities, there cannot be a doubt but that this coal basin and the railroad leading to it will yet eclipse all their cotemporaries in the magnitude of their operations.

IRA SPAULDING,

Dauphin, Pa., July 1844. *Chief Engineer, B. M. Railroad.*

We published in our June number a letter from Ira Spaulding, Esq., chief engineer of this road, showing that a new route had been discovered far more favorable than the one formerly contemplated through Lykins valley. It will be seen by reference to that letter, (page 171, June No.), that a saving of 14 miles in distance will be effected, and that instead of from a level to a maximum grade of 36 feet per mile, they will now have a *regular descending grade* of about 17 feet per mile from the *heart of the coal veins* to the canal at Dauphin, eight miles above Harrisburg.

We now give a further account of this remarkable work, with illustrations, showing the position of the coal bed, and the manner in which it is perforated by the railroad tunnel, of a mile and a half in length, which passes through at least fifty veins of coal, of from four to thirty feet in thickness, at a thousand feet below their outcropping. A position more favorable for working, it would seem to us, could not have been devised by the most ingenious and selfish man—as it may be led in shutes directly into the cars—and the road itself, having 17 feet fall, forms an ample drain to lead off the water—thus avoiding the immense expense at many other collieries of raising the coal and draining the mines by steam power.

We desire to make our acknowledgments to Messrs. Spaulding and Sickles for their remembrance of the Railroad Journal, in laying the merits of their work before the public. We hope to hear from them again soon in relation to their progress.

UTILITY OF WIRE ROPES.

The following statement, from the London Mining Journal, in relation to the use of wire ropes for coal mines, may be useful to those in this country requiring ropes for such purposes, or for inclined planes, as well as our worthy friend, Mr. John A. Roebling, of Saxonburg, Pa., who is engaged in the manufacture, as will be seen by reference to the Journal of November last—therefore we transfer it to our pages.

"The question of the comparative strength of hemp and wire ropes used in the 'winning' of coal, and, indeed, for every other purpose for which rope is applicable, having been frequently discussed in our columns, we have pleasure in complying with the request of a correspondent, by inserting the following communication, addressed to Mr. Newall, manufacturer of wire rope, by so distinguished a colliery reviewer as Mr. Matthew Liddell, dated from Benton Grange:

"'Dear Sir—I consider the following information may be interesting, and certainly goes far to establish confidence in the equal security of flat wire ropes with those made from hemp, when exposed to a sudden violent strain; which, it has been stated, would cause the former to snap, or break. On Monday, last, when employed in drawing coals, the breaksman of the engine, (46 horse power) on which a pair of your flat wire ropes were put in June last, neglected to check the engine on the approach of the cage and tubs to the surface; and, consequently, the engine continued at full speed, (the rope moving about 120 fathoms a minute), until suddenly stopped by the cage coming into violent contact with the pulley. The shock slightly displaced the pulley frame, when the rivets of the shackle which you attach

to the end of the rope where the cage is hung on to it, were drawn through the strands of the rope, and the cage and coals fell on the 'keeps' at the top of the pit, which prevented their falling down the pit, so that the damage done was trifling. I have since then had the wire rope examined, and, although the strain on it must have been very great to stop the engine, yet it does not appear to have sustained any injury, and is, apparently, as good as when it was first put on. MATTHEW LIDDELL.'"

SAULT DE ST. MARIE CANAL, AND ST. JOSEPH'S RAILROAD.

We have received, since our July number was put to press, a communication from the Hon. Mr. Woodbridge, of Michigan, in relation to the defeat of the bills before congress in aid of these important works, accompanied with various documents of interest, in relation to the Canadian canals and plank roads, together with the annual report of the board of internal improvement, of Michigan, for which we desire to tender him our thanks. We shall avail ourselves of their use, and then dispose of them in accordance with his directions.

HUNT'S MERCHANTS' MAGAZINE.

This popular and useful work was punctually on our table, and is, as usual, filled with useful information for the business man; and it should be on the desk of every merchant in the Union, and be read attentively by every clerk, as well as merchant.

PARSONS' LOCOMOTIVE EXPANSIVE APPARATUS.

The following communication from Horatio Allen, Esq., copied from the Franklin Journal, exposes one of the numerous *piracies* perpetrated by designing knaves upon ingenious inventors.

"SIRS—The March number of the Journal of the Franklin Institute contains a description of 'Parsons' locomotive expansive apparatus.' That part of the arrangement which provides an adjustable cut-off, by the use of two slide valves attached to the same rod, one by right handed, the other by left handed, screws, and the mode, adjustment, etc., are precisely those for which I obtained letters patent in August, 1841. The American Repertory for December, 1841, contained a part of my specification and claim.

"The patent of Mr. Parsons is dated December, 1842, and was enrolled in June, 1843.

"The 'adjustable cut-off,' as my invention is named, has been adopted on an engine lately put to work on the railroad from Jersey City to New Brunswick, to one on the Long Island road, and to engines building for the Patterson road, and for the Stonington road.

"I intend soon to send you accounts of the performance of these engines, which have been very satisfactory, and shall also furnish a full description of the combinations embraced in my patent. Yours respectfully,

"*New York, May* 14, 1844. HORATIO ALLEN."

Mode of Floating Large Stones for Building Sea Walls in Deep Water.—At the meeting of the institute of civil engineers of the 12th March, Mr. Bremner read a paper describing the casks used for floating the large stones for securing the foot of the sea wall of Banff harbor, which had failed. The casks were strongly built of fir staves, hooped externally with iron, and supported inside by radiating bars like the spokes of a wheel. Two of

these casks, of 445 cubic feet capacity each, were use to convey stones of 30 tons weight, by passing two chain cables, which were wound round them, through the eyes of the lewises, which were fixed in the stone at low water, at which time the chains being hauled down tight, when the tide flowed, the buoyancy of the casks floated the stones, and they were towed by a boat over the place where the stone was intended to be deposited. The lashing being then cut away, the stone fell into its seat. This method was found to succeed in weather that would have destroyed any crane barges; and the works of Banff harbor were thus secured from further degradation, and were subsequently restored at a comparatively small cost.

Mode of making Looking-glasses, Mirrors, etc., without Mercury.—A correspondent (J. B. N.) sends us the following particulars of a process by which looking glasses, etc. may be silvered in the most effectual way without the use of mercury; he has done several; "the most splendid mirrors imaginable." The following is his account of the process:—"Take a little nitrate of silver; add carefully liquid ammonia till the precipitate formed is nearly all dissolved, but not fully; add a little of this to a mixture of alcohol and oil of cassia; the piece of glass to be silvered is laid flat, with a ledging tied round of pipe clay or the like, exactly as if a mould were to be taken; upon the glass pour the above named mixture till it has a depth of between a quarter and half an inch; then drop here and there upon this a mixture of oil of cloves and alcohol; a violent action takes place where the drops fall; this rapidly spreads, and the whole surface, in the course of from a quarter to half an hour, appears brown; the liquid is now poured off, and a layer of silver is found reduced upon the surface of the glass, forming a complete and beautiful mirror ready to be framed. The chemical action is no doubt the formation of aldehyde which reduces the silver. This process has recently been made the subject of a patent, for which, I am told, the firm of Rothschild has offered £100,000 for the purpose of suppressing the discovery, as it may affect the valuable monopoly in mercury possessed by that house. The offer has been refused. The name of the patentee, I am informed, is Durant, of Brighton." The process of silvering by means of aldehyde was exhibited two years ago at the Glasgow Philosophical Society, by Dr. Stenhouse.

Scaffolding.—Two papers on this subject were read at the same meeting of the Institution. The first paper was read by Mr. T. Grissell, in which the author described the scaffolding first used by Mr. Cubitt for the erection of the facade of the Birmingham railway station, and which had since been adopted for other works with complete success. It was stated to be composed of sills, uprights, cross-heads, longitudinal timbers, braces and struts, all of whole timber. The upright timbers were slightly turned into the horizontal timbers with junctions secured by iron dogs, driven into the timbers diagonally across the joints, which were preferable to bolts and spikes, inasmuch as they could be easily withdrawn, and the timber was not injured. The next paper on the subject was by M. Pierre Journet, whose scaffolding was stated to consist of a simple combination of a number of brackets, fixed at regular distances of about five feet apart vertically, upon girdles of chains and screws, braced tight round the column under repair: upon these brackets the platforms were laid, and as the workmen proceeded upwards, the lower brackets were alternately raised to the platforms above, where the workmen stood. The progress thus made in forming, and in taking down a scaffold, was stated to be very rapid, with corresponding economy of time and expense; no poles or cords were used and no waste of material occurred. By these means the obelisk of Luxor, at Paris, was repaired in a very short time and at a very small cost. The machine for raising building materials consisted of an endless chain of square open links, the lower end revolving around a driven wheel, and the upper end around a corresponding wheel, fixed upon a scaffold, at the height of the building. The hods, buckets and baskets were each furnished with a hook by which they were suspended on the rising side of the chain, and when they arrived at the necessary height they were taken off by laborers, and carried to the spot where the materials were to be used; when empty they were hung upon the descending side of the chain and lowered to be again filled.

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THE ATMOSPHERIC RAILWAY.

Evidence given before a Committee of the House of Commons.

Mr. Barry Gibbons, engineer of the Dublin and Kingstown railway, examined: Trains propelled on the atmospheric principle started and stopped more easily, and with less loss of time, than those with locomotive power. The atmospheric principle on the Dalkey line, compared with the expense of other lines, as to haulage, was much cheaper than the locomotive. The maintenance of way was less favorable in a newly opened line than on an old one. Taking the cost of haulage on the locomotive line of the Dublin and Kingstown, according to the published accounts of the company, the cost of locomotive power on that line was 10 9-10*d*. per train per mile. The maintenance of way was 3 1-10*d*. making a total of 14*d*. The cost of moving power on the atmospheric principle was 7 1-10*d*. and the maintenance of way 1 3-10*d*. Could distinguish the wear and tear of rails on a locomotive line in the space of six weeks. In the estimate of 14*d*. there was an allowance made for wear and tear of rails. In the atmospheric there was no parallel allowance for the pipe. Believed, though there were great curves on the line, that there was no wear and tear of the pipe, and no centrifugal friction. The wear and tear of the pipe would not require an expenditure for fifty years. It became perfectly polished inside, owing to the tallow. In going round sharp curves on a locomotive line, the inside of the rail is worn away by the flange of the wheel. Did not make any allowance in the estimate for wear and tear of rails on an atmospheric line, because it was inappreciable. In the item for haulage, witness debited wear and tear to the atmospheric railway, which would take place in the stationary engines, and included coals consumed, wear of machinery, and persons employed in the engine house. The cost of coals was 1*l*. 4*s*. 6*d*. per day; wages 12*s*.; wear and tear, oil. etc. 6*s*. If the Dalkey line were longer, the expense would be less. Had laid out an extension of it to Bray, six miles, and an engine would work at both places. There would be more consumption of coal, but at less per train per mile. Paid Messrs. Samuda for the construction of the line, and their estimate was not exceeded by 1*d*. Their promises as to load carried, and velocity attained, had been perfectly accomplished. They entered into a contract to carry trains of 26 tons at 30 miles an hour, and had performed it at double that rate. The Dublin and Kingstown was a very cheap line, and the low fares had in-

creased the passengers enormously. The trains had been increased from time to time, and there had been a corresponding number of passengers. It induced a system of country residence. They estimated that every new house built in the neighborhood of a station was 20*l.* added to the annual receipts. There were four stations on the six miles. The fares were 1*s.*, 8*d.*, and 6*d.*, but there was a reduction to families of 5, 10 and 20 per cent. The average fare was something under 1*d.* The fares on the Dalkey were 2*d.* and 3*d.* They would pay at that. The company received 45*l.* on last Sunday, which would represent 4500 persons. The increase in traffic on the Kingstown railway was not so much to be attributed to reduction of fares as to the frequency of the trains. The coals consumed by the engine on the atmospheric line were 35 cwt. per day, which would keep it working from 8 A. M. to 6 P. M. at intervals. Witness reckoned a daily mileage allowance for wear and tear of piston of 4*d.* per day. One set of piston leathers, costing 16*d*, worked a fortnight. The rails on the atmospheric line were 52lb. per yard weight. Had examined the pipe, and could find no lateral pressure made by the tube on the piston. The straightforward movement of the piston counteracted the centrifugal force of the curve; but witness did not think that the piston had ever been brought into operation to prevent the carriages going off the line. If it had ever exerted such a force there would have been some indication of it on the pipe. The atmospheric carriages were 15 cwt., or a ton lighter than the locomotive. Witness's estimate for maintenance on the locomotive line was for a double, the estimate for the atmospheric for only a single line. Had made the experiment of stopping the trains almost instantaneously, and had brought up a train to a dead rest, travelling at 40 miles an hour, within 220 yards. There were 7 carriages, and 78 persons in them. The weight of the rails on the Kingstown and those on the Dalkey was precisely the same. The calculation given by witness of 7*d.* for haulage on the atmospheric, was only for one way. If worked backwards and forwards as a locomotive, it would be 14*d.*; but the trains came back by their own gravity, and therefore cost nothing. Were the line on a level, the cost would have to be doubled.

Mr. I. K. Brunel, C. E., examined: Had been consulted on the expediency of working the proposed Croydon and Epsom on the atmospheric system, and had considered its application thereto very fully. Thought that the adoption of the atmospheric plan was well adapted for the working of the proposed line. Taking all things into consideration, the trains could be conveyed in a shorter time by it than by the ordinary locomotive engine, and with greater frequency. Where the trains were not very numerous, could understand that the working expenses would be less by locomotive power than by a fixed engine. In a great number of cases it would be the reverse; the working expenses would be reduced by the atmospheric principle, assuming that a great many trains would run. The prevailing gradients on the Epsom line were 1 in 100, which he thought applicable to a line with a view to economy in working. The diagrams of Mr. Samuda, as to the manner of working the trains might be worked with frequency and safety. There was a point where expensive locomotive power would become more economical than stationary power, if the number of trains were very much reduced. Thought that the atmospheric train could be propelled much faster than is done at present. Had no reason to doubt but that trains might go at a speed of 50 and 60 miles an hour. Had gone at 60 on a locomotive, and thought a train might go easier and at a higher rate by the atmospheric than by the locomotive engine. It had greater speed than the locomotive. It possessed the advantage over the latter of

starting at once into a state of motion from a state of rest. This was a great advantage where there were many stations, as contemplated in the Epsom line. On the Great Western they found that it was six to eight miles from the station before they got into a good maximum rate of running; therefore it was only on a long distance from London to Slough that they did attain their full velocity. With respect to the atmospheric attaining a velocity of 50 miles an hour, it would depend entirely on the power, the size of the pipe, and the degree of vacuum. Did not see any difficulty in their getting it at the end of 2½ or 3 miles. Had no doubt but that if they chose to put on the power, they might obtain it at 1 mile or 1½. When witness saw the line at Dalkey, it was not laid in a manner which admitted of a very high velocity. Did not think it safe when he made the experiments to go higher than 40 miles. The derangement of the rails, and the difficulty of keeping the railway in perfect order, arose from the weight of the locomotive engines, and the mode of working them on the rails. Witness's object in making the experiments at Dalkey was to satisfy his own mind, with a view to govern him in advising others. The results of these experiments were, that he found they could attain a high velocity on the line in a short time, so as even to attain the rate of 50 miles an hour. Found that the mechanical part of the apparatus and valve was even then in a good working condition, and saw enough to satisfy his mind that it could be rendered still more perfect. Found that a weight was moved at a good velocity of 22 miles an hour—a weight fully as great as that due to the free effect of the vacuum in the piston. Satisfied himself that there was no amount of friction or leakage round the piston, nor other mechanical defects, which would prevent getting the full effect of the vacuum. Was confirmed in the opinion that a mechanical contrivance of that sort could be worked, so as to produce that effect at a less cost than the ordinary mode of applying power by a locomotive. Had in consequence of these experiments advised the promoters of the Croydon and Epsom to adopt the atmospheric. Had no doubt that an atmospheric railway might be made more comfortable to passengers than a locomotive, which was one of the great advantages to be derived from it. Thought that the rails might be kept in much more perfect order than with locomotive carriages; and that carriages might be constructed in a totally different manner from those now in use. The motion would be smooth and noiseless. There was also the absence of coke dust from the chimney. With respect to the experiments of stopping trains, thought that on a railway worked by stationary power, whether atmospheric or other, the power of stopping was greater than it was on a locomotive line. The power to be overcome in stopping a train arose, not from the power of friction, but from the momentum of the train, which, at 40 miles an hour, would be 10 or 15 times as great as the power of traction that could be produced for a distance of 250 yards; and therefore in stopping a train at a short distance of 250 yards, what they had to think of was the momentum of the train. Did not think that the reversing of the engine at all equalled the advantage that might be derived from breaks or slides, such as those Mr. Cubitt spoke of on carriages on the atmospheric line. The reversal of an engine for stopping a train did not produce so much effect as might be supposed. On the Great Western they never reversed; but the break in the tender stopped the train at high velocities. Had calculated the power of the engine at Dalkey. In a commercial point of view, Mr. Samuda's mode of calculating was correct. The power on the atmospheric railway had a facility for adapting itself to the load. That was a great advantage. Where the gradients were steep they could apply more power.

Assuming even that the pipe was not of the same size everywhere, at one small steep part of the line they might work a vacuum up to 18 or 20 inches of mercury, which would not be so economical as working it at 14 or 16 inches. Still, for a short part of the line, they could do so; whereas on the rest of the line they might work at the more economical pressure of 14 to 16 inches of mercury. With respect to the variation of the work, according to the variation in the weight of the train, of course any engine working expansively, and well constructed, would adapt itself to the weight of the train; and the cost of working the engine would be somewhat proportional to the weight. Was so satisfied of the advantage of the atmospheric, that he had proposed to adopt it on the line (26 miles) he was now surveying from Croydon to Chatham. An advantage of the atmospheric was, that when a train stopped at the station, the power for propelling was accumulating in the pipe, so as to bring the train more rapidly into motion from the state of rest. Witness's preference of the atmospheric was limited to cases where the passage of trains was required to be frequent. Had no hesitation in saying, that if the two lines now before the committee were to be worked by locomotive power, the Southwestern would be the cheapest and safest; but if the atmospheric were applied, it could be done cheaper by the Croydon and Epsom. Had no doubt but that the atmospheric upon a single line, where everything was adapted to it, was much safer than a locomotive on a single line with double power. The atmospheric might be so managed that no carelessness could produce a collision; but it was impossible on a locomotive line to prevent one train catching or meeting another. Thought that the leakage could safely be neglected. Did not think that any experiments which had yet been made would enable a correct calculation to be made of the amount of power required to overcome the leakage. He spoke guardedly and carefully, inasmuch as he was expressing an opinion adverse to that of his friend, Mr. R. Stephenson, whose report he had seen. Thought there was no difficulty in constructing carriages in the manner stated by Mr. Cubitt, by bringing them at once on slides or sledges, or by locking all the wheels of one entire train, which, now that they used steel tires, he should not be afraid of doing. Thought there would be no difficulty at all in keeping the atmospheric railway in such good order that the carriages might be better constructed and connected one with another, so that the break might be made to act in the whole at once. There had lately been introduced a new mode of valve-gearing, which facilitated the adaptation of engines to the load. The practical effect of the expansive gear was rather to put larger cylinders on the engine, and to work economically, than to vary the power much, because the variation of power between shutting off the steam was not very great. The sole object of this improvement was, by the use of a rather larger cylinder than was necessary to enable the steam to be used expansively, and thereby obtain economy of fuel. Was among the first to use the expansive gear on the Great Western, but had no such object as the saving of steam in going down an incline, in order to reserve it for use in going up an incline. Had advised a line between Chatham and Croydon to be laid down on that principle, and also between Genoa and Turin, which was over a steep part of the Apennines. Witness wished to be allowed to explain himself more particularly on one point, as he was now giving an opinion professionally, and more particularly as a report had just been published by an eminent—probably the most eminent—man in his own profession, in which a strong opinion was expressed on all these points diametrically opposite to those which he entertained. He should wish it to be understood that he was not

carelessly giving any opinion now without recollecting that circumstance, and he should, in his own vindication, repeat the object of his making the experiments at Dalkey, and also say, with sentiments of much respect for Mr. Robert Stephenson, that he still thought it possible to form a more correct opinion on this particular case by a general practical view of the working of the Dalkey line, and of the modifications of which it was susceptible when applied to longer lines, than by the very minute calculations and minute experiments recited in Mr. Stephenson's report. In the first place, the Dalkey line was too short, and, he must say, too badly constructed, owing to local difficulties, to allow either velocity to be attained or the train to be worked, with ordinary average resistance. Believed that resistance upon that line was much greater than it was on a good railway; and that there were sources of great loss of power in the connecting pipe and other parts which, according to his opinion as a mechanical man, might be easily remedied and overcome.

Mr. R. Stephenson's objections will be found substantially in the following extracts from his report, for which, as well as for the preceding abstract we are indebted to the Railway Chronicle.

"My first impression was that much higher velocities were attainable by the atmospheric system than had yet been accomplished by locomotive engines; but a very careful reflection upon all the circumstances which the last series of experiments developed and, the detailed calculations which have been made upon them, has led me to alter that impression. I am fully aware that the calculations which have been given do not absolutely put a limit to the speed, and that the investigation may resolve itself merely into a question of power, and consequently into one of expense; to a certain extent, this is the case, but an inquiry of this kind, which is as essentially commercial as scientific, is one in which pecuniary limits must continually present themselves, and not unfrequently prove more formidable than those of a mechanical nature. In pursuing my calculations, therefore I have felt that it was imperative to determine with some accuracy the probable additional power which it would be necessary to reckon upon, beyond that which has been employed at Kingstown; and I am convinced the increase which has been stated as requisite to attain the assumed velocity of 50 miles per hour is rather under than over estimated; and this single example, based as it is entirely upon experimental data, is sufficient, in my opinion, to demonstrate conclusively, that any velocity beyond that which is now frequently attained upon railways, must be attended with a most inordinate waste of power. I have already contrasted the actual velocities of the trains with those which would be indicated by theory, and have shown that the loss of velocity arises solely from the leakage of the apparatus, and that as the rarefaction is increased this content of leakage becomes augmented, while the pump is only capable of exhausting a constant content of air without reference to the density. This leads us to the conclusion that when the barometer rises to within a few inches of its utmost height, the expansion of the air leaking into the apparatus must become fully equal to the total capacity of the pump, and no advance of the tube piston can be effected. The case occurs on the Kingstown and Dalkey railway, with a height of barometer of 25½ inches, which is the maximum height that can be attained in the entire length of the vacuum tube; and therefore a train requiring this height of barometer could not be started if the air pump did not exceed its uniform rate, although the engine would be working at almost its greatest power. This conclusion, which is unques-

tionably correct, points out the improvident expenditure of power when a high degree of rarefaction is required."

Having thus removed the great claim made by the inventors to the exclusive enjoyment of high velocities, Mr. Stephenson next proceeds to compare the work actually done by the atmospheric system on the Dalkey line with the work actually done by *stationary power and rope system*, as now in use at Camden-town. The comparison is fair, in this respect, that the Camden-town incline is 1 in 106, and the Dalkey incline is 1 in 115 being in favor of the atmospheric; only there are sharp curves on the latter, which do not exist on the former. The results of the comparison may be arranged under several heads, as follows:—

1. *Loss of power* by rope and atmospheric tube:—

"In proceeding to compare with these the results of the experiments on the atmospheric railway, it is my object to select a case in each, which shall present the closest analogy in the amount of their resistances and velocity. The 4th train in table No. VII, and the 18th in table No. V, correspond very closely in these particulars, the total resistance of the former, including the friction, gravity, and resistance of atmosphere, being equal to 102 horses' power, and of the latter, 100 horses' power, and the respective velocities being 20 and 18 miles per hour. The loss of power from the working of the rope in the former case is equal to 30 per cent. of the total, while the loss in the latter, arising from raising the vacuum, leakage, and imperfections of the apparatus, amounts to 74 per cent. of the total power. In order however, to institute a correct comparison between these two cases, the total power in the former must be increased in the proportion of the mean to the maximum velocity, which in this instance is ascertained, from experiments made, to add 37 horses' power to the total, and the comparison stands thus: the loss of power on the Euston incline amounts to 45 per cent., while that on the Kingstown and Dalkey railway is 74 per cent. The result is obtained with a train which represents the average working of the Euston incline; it is therefore evident that in this particular instance the rope is very considerably more economical than the atmospheric system. If we assume other weights of train, we shall perceive, that as they become lighter the proportion of loss by the atmospheric apparatus will be diminished on account of the reduction in the effect of leakage accompanying the reduction in pressure, but the proportion of loss by the rope will be increased, as the power required to work the rope itself is the same with a light as with a heavy train; while on the other hand, with heavier trains the proportion of loss by the rope will be diminished, and that by the atmospheric system greatly augmented, from the increased effect of the leakage, and the additional power required to raise the vacuum to a greater height."

2. *Consumption of fuel* by the rope system and the tube system compared:—

"This I am enabled to accomplish from the observation of a fortnight's working of the Euston incline, and from an experiment on the Kingstown and Dalkey railway, in which the number of trains, the exact weight of each, and the consumption of fuel, was ascertained during an entire day. The result of the former was, that 13 trains averaging 41 tons each, the mean resistance of which amounted to 1590 lb., were drawn up the incline of 0·91 mile length, at a mean velocity of about 17 miles per hour, in one day of 15 hours, with a consumption of 30 cwt. of coal; and the result of the latter was that 10 trains averaging 44 tons each, the mean resistance of which amounted to 1205 lb., were drawn up the incline of 1·22 miles

length, at a mean velocity of about 14 miles per hour, in one day of eight hours, with a consumption of 29 cwt. of coal. The consumption of coal per mile of the trains in these two cases amounts to 284 lb. on the Euston incline, and 266 lb. at Kingstown; and dividing these by their respective amounts of friction and gravity, we obtain the comparative consumption per lb. of tractive force as ·18 lb. in the former case, and ·21 lb. in the latter."

3. Power of *overcoming bad gradients*:—

"If we take some of the trains which are drawn up the Euston incline, amounting to fully 100 tons weight, we shall find that the total resistance exceeds the capacity of the tube which is employed at Kingstown, namely, 15 inches diameter; for supposing the pressure to be equal to 22 inches height of the barometer, or 11 lb. per square inch, the train just named upon the gradient of 1 in 75, which is near the upper end of the Euston incline, and continues for about one-third of its length, would offer a resistance, at a velocity of 17 miles per hour, of about 4,500 lb., and would therefore require a tube of 23 inches diameter. Such an increase of tube, it must be observed, immediately implied a great reduction of velocity with the atmospheric system, or an increased size of air pump, involving a corresponding increase of power, because the ratio between the areas of the air pump and vacuum tube is affected; and it has been clearly shown that, working at a high vacuum in a small tube, or increasing the size of the tube and lowering the vacuum, if the same amount of power be employed, involves equally the sacrifice of velocity. Here we perceive a decided proof, that what is termed good gradients is not a matter of indifference to the atmospheric system, and that we shall not be justified in attributing to it the power of economising the construction of railways to any considerable extent, by avoiding the necessity of levelling the face of the country."

The comparison with the locomotive, even in duty alone, is also of a kind unfavorable to it, keeping out of view altogether the peculiar disadvantages of stationary as compared with locomotive power. The result is as follows:

"If we convert the loads moved in the experiments into equivalent loads on a level, we shall then find that in no case they exceed the duty which is being daily performed by locomotive engines. Thus, taking experiment No. 4, the load being 26·5 tons, the resistance per ton upon an incline of 1 in 115, at a velocity of 34·7 miles per hour, estimating the resistance of the atmosphere according to Lardner's experiments previously referred to, will stand thus—gravity, 20 lb. per ton; friction, 10 lb.; atmosphere, 20 lb.: total resistance, 50 lb. per ton. And the resistance upon a level will be—friction, 10 lb. per ton; atmosphere, 20 lb.: total resistance, 30 lb. per ton. Therefore this train of 26·5 tons, on the incline of 1 in 115, will be equivalent to 44 tons upon a level, at the same speed of 34·7 miles per hour. This duty, which is indisputably the utmost given by the experiments at Kingstown, is much exceeded daily on many lines of railway in this country, and especially by the Great Western, and Northern and Eastern. Throughout the experiments, it will be seen that the duty performed by the Kingstown and Dalkey engine, when reduced to an equivalent level, falls short of the daily performance of locomotive engines on our principal lines of railway, both as regards speed and load."

The conclusion of the whole matter, considered as a purely mechanical question, is given in the following sentences:—

"On a long series of bad gradients, extending over several miles, where the kind of traffic is such that it is essential to avoid intermediate stoppages, the atmospheric system would be the most expedient. If, however, intermediate stoppages are not objectionable, as is the case in the conveyance of

heavy goods and mineral trains on the railways in the neighborhood of Newcastle-upon-Tyne, the application of the rope is preferable to the atmospheric system. This conclusion I conceive to be fully established by the comparison which has been made between the Kingstown and Euston inclines. Again, on lines of railway where moderate gradients are attainable at a reasonable expense, the locomotive engine is decidedly superior, both as regards power and speed, to any results developed or likely to be developed by the atmospheric system. In considering these last, as well as all the preceding calculations and remarks, it must be borne in mind that they have reference solely to the question of power, and are entirely independent of the question of expense or convenience: the next step in the inquiry will therefore be, the expense of constructing the lines on each system and the probable cost of working."

Hitherto the question has been treated wholly as one respecting the value of a given mechanical means of transmitting power.

There remain to be considered the questions of *cost and convenience;* and here, as well as throughout the whole line of argument, there will be observed a close analogy between the results and reasonings of Mr. Stephenson's report and those in pp. 102, 103 of our last, already referred to.

The inventors of this system, in vaunting its excellence, rely much on the supposed advantage of being able to work with single lines. This Mr S. completely refutes: he proves the necessity, not only of two lines, but of duplicate engines. This raises the cost of the atmospheric to £11,000 per mile; so that on such a line as the London and Birmingham, the total cost, in all items, for locomotive power, is - - - - £321,974
and for the atmospheric, - - - - - 1,221,000

But even the expense of working, after all this greater expenditure of capital, is against the atmospheric.

The cost of locomotive power upon the London and Birmingham railway, for 1843, was as follows:—

"Wages of engine drivers and firemen, - - - -	£9,673	
Coke, - - - - - - - -	25,541	
Oil, horse pipes and fire tools, pumping engines and water, -	4,099	
Laborers and cleaners, waste and oil, - - - -	4,194	
Repairs of engines and tenders, - - - - -	12,521	
Coals and fire wood, expenses of stationary engine at Wolverton, repairs of buildings, gas and incidental charges, - - - -	3,172	
Superintendent, clerks' and foremen's salaries, and office charges,	4,634	—£63,834

The expense of working the atmospheric system for one year, I estimate approximately as follows:—

"Wages of engine men, 64 at 6s.; stokers, 64 at 3s., -	£10,512	
The same during the night, - - - - -	10,512	
Coal, 172 tons per day, at 9s., - - - - -	28,332	
Oil, hemp, tallow and repairs at 5 per cent. on cost of engines, -	20,000	
Superintendence same as locomotive, - - - -	4,634	—£73,990

I have already stated that the above sum has no pretension to precise accuracy, but since I have intentionally omitted numerous items of expense, which must arise (the exact amount of which no one can venture to predict or to introduce into such a calculation with much confidence,) I prefer making the comparison under that aspect which is the most favorable to the new invention under discussion; because I conceive the question between the atmospheric and locomotive systems does not by any means, after what has been advanced, depend on the mere annual cost of working. I shall content myself with the above statement, which in my opinion sufficiently establishes the fact, that the cost of working the London and Birmingham

railway, or any other line with a similar traffic, by the atmospheric system would greatly exceed that by locomotive engines."

But, to do the system full justice, a single line, the favorite instance, may be taken at their own estimates; and the result entirely coincides with that given by our correspondent S., in our last.

"Let us now conceive it applied to a case of an opposite character; for example, the Norwich and Yarmouth railway, which has cost about £10,000 per mile, including carrying stock and every appurtenance. This line passes over a country in which the application of the atmospheric system could have effected no economy in the formation of the line, which has not exceeded a cost of £8,000 per mile. The application of a single line of the atmospheric apparatus would, in this instance, have added at least £5,000 per mile, which upon 20 miles, the length of the railway, would amount to £100,000. The mere interest of this sum, at 5 per cent. is £5,000 per annum, whereas the actual working of this line, including maintenance of way, booking offices, porterage and all other constant traffic charges, has been let for £7,000 per annum, being only £2,000 above the bare interest of the extra capital which would be required to lay down the atmospheric apparatus; an amount which would be quite inadequate to meet the wear and tear of the machinery alone, leaving nothing to meet the current cost of working. Here, therefore, we have a case, where the country is favorable, the original capital small, and the traffic moderate, where the cost of the atmospheric system would be so burdensome as to render it totally inapplicable."

In the appendix, the comparison of the atmospheric system with that on the Blackwall railway is given with great clearness by Mr. Bidder, and leads to this conclusion, that—

"Unless some expedient with which I at present am unacquainted can be devised for obviating the necessity of stopping at each intermediate station, it would appear that the trains could not be run more frequently than at half hour intervals with the engines now at work, thus reducing the trains to one half their present number, and this, too, without effecting any saving in the working expenses, inasmuch as there would be no reduction in the staff of conductors while the constant and severe breaking would increase the cost of maintenance of way and carriages; the wages of the rope men also would not compensate, for the extra cost arising from the engines being kept continually at work, instead of for ten minutes only out of every quarter of an hour, as is now the case; and lastly, the interest of the outlay requisite to introduce this system would exceed the annual cost of reparing and replacing the rope."

Mr. Stephenson sums up the whole case thus:—

"1st. That the atmospheric system is not an economical mode of transmitting power, and inferior in this respect both to locomotive engines and stationary engines with ropes. 2nd. That it is not calculated practically to acquire and maintain higher velocities than are comprised in the present working of locomotive engines. 3d. That it would not in the majority of instances produce economy in the original construction of railways, and in many would most materially augment their cost. 4th. That on some short railways, where the traffic is large, admitting of trains of moderate weight but requiring high velocities and frequent departures, and where the face of the country is such as to preclude the use of gradients suitable for locomotive engines, the atmospheric system would prove the most eligible. 5th. That on short lines of railway, say four or five miles in length, in the vicinity of large towns, where frequent and rapid communication is required

between the termini alone, the atmospheric system might be advantageously applied. 6th. That on short lines, such as the Blackwall railway, where the traffic is chiefly derived from intermediate points, requiring frequent stoppages between the termini, the atmospheric system is inapplicable; being much inferior to the plan of disconnecting the carriages from a rope, for the accommodation of the intermediate traffic. 7. That on long lines of railway, the requisites of a large traffic cannot be attained by so inflexible a system as the atmospheric, in which the efficient operation of the whole depends so completely upon the perfect performance of each individual section of the machinery."

Mr. Herapath takes strong ground against the atmospheric railway, and speaking of the great loss of power from the friction of the air in the pipes, says:—

"That I am not unsupported in the views of the inefficiency of these atmospheric machines, I shall show by a quotation, furnished me a few days ago by a friend, from Dr. Robison's Mechanical Philosophy. The first experiment was made by Papin, an able man of science and a very eminent engineer. The second seems also to have been made by a good engineer and it is therefore presumed that both of these facts ought to be well known to our engineers of the present day. It is to be lamented that the size of the tubes is not mentioned, but doubtless they were small, perhaps only a few inches in diameter. As bearing, however, on the general question of the great amount of friction of air in tubes, it is not material to know the exact size.

"Dr. Papin, a most ingenious man, proposed this (the motion of air in pipes) as the most effectual method of transferring the action of a moving power to a great distance. Suppose for instance, that it was required to raise water out of a mine by a water machine, and that there was no fall of water nearer than a mile's distance. He employed this water to drive a piston, which should compress the air in a cylinder communicating by a long pipe, with another cylinder at the mouth of the mine. He expected that as soon as the piston at the water machine had compressed the air sufficiently, it would cause the air in the cylinder at the mine, to force up its piston, and thus work the pump. Dr. Hooke made many objections to the method when laid before the Royal Society, and it was much debated there. But dynamics was at this time an infant science, and very little understood. Newton had not then taken any part in the business of the society, otherwise the true objections would not have escaped his sagacious mind. Notwithstanding Papin's great reputation as an engineer and mechanic, he could not bring his machine into use in England: but afterwards in France and Germany, where he settled, he got some persons of great fortune to employ him in this project; and he erected great machines at Auvergne and Westphalia, for draining mines. But so far from being effective machines, they would not even begin to move. He attributed the failure to the quantity of air in the pipe of communication, which must be condensed before it can condense the air in the remote cylinder. This indeed is true, and he should have thought of this earlier. He therefore diminished the size of this pipe and made his water machine exhaust instead of condensing, and had no doubt but that the immense velocity with which air rushes into a void, would make a rapid and effectual communication of power. But he was equally disappointed here, and *the machine at the mine stood still as before.*

"Near a century after this a very intelligent engineer attempted a much more feasible thing of this kind at an iron foundry in Wales. He erected

a machine at a powerful fall of water, which worked a set of cylinder bellows, the blowpipe of which was conducted to the distance of a mile and a half, where it was applied to a blast furnace. But notwithstanding every care to make the conducting pipe *very air-tight, of great size, and as smooth as possible*, it would hardly blow out a candle. The failure was ascribed to the impossibility of making the pipe air-tight. But what was surprising, above ten minutes elapsed after the action of the piston in the bellows, before the least wind could be perceived at the end of the pipe; whereas the engineer expected an interval of six seconds only."

It was our intention to have offered some remarks of our own on this novel and extraordinary project; but when we find such men as R. Stephenson and Brunel entertaining diametrically opposite opinions after actual examination, we think it will better become us to merely submit their views to our readers. The cost alone will prevent the possibility of its adoption on the vast majority of roads in this country, though we think that the coal region of Pennsylvania affords some suitable openings.

It will be seen that Mr. Stephenson deduces all his conclusions from his own experiments, considering them as infallible, while Mr. Brunel founds his opinion on what—judging from the present state of things—may reasonably be expected from experience skill and observation, and we think this is with *practical* men the safer mode.

CENTRAL RAILROAD, GEORGIA.

This important work, the longest railway in existence, is now completed and the following extracts from the report of the engineer, Mr. L. O. Reynolds, will give our readers a good idea of the railway generally.

"The quantity of excavation and embankment throughout the whole line is about five million six hundred thousand cubic yards. There are, including the long bridge over the Oconee swamp, about six miles in extent of trestle bridging; about one-third of this may be, at a future day, filled up with earth.

"The road-bed is graded to a width of 15 feet on the embankments, with slopes of one and a half base to one vertical. The excavations below station No. 10, are generally graded 25 feet wide; beyond that station, 20 feet; side slopes generally, 45 degrees—except in loose soils, when they are similar to the embankments, and in some instances two to one.

"There has been no rock excavation of consequence, but many of the cuts have been through a compact mixture of clay and sand, which required the aid of the pick in excavating.

"Considerable work will be necessary during the present and next years, in extending and perfecting the drainage of the road. Nothing is more important than good drainage to insure a firm and even track.

"The maximum inclination of grade of the road is 30 feet per mile. Although I have inserted a table of the gradients and curves of the road in a former report, I will repeat that they may be classed as follows:

	Miles.	Feet.
Level, ...	26	4,378
Inclinations not over 5 feet per mile,	44	4,880
" from 5 to 10 " "	30	4,600
" " 10 to 15 " "	17	4,240
" " 15 to 20 " "	13	3,160
" " 20 to 25 " "	9	3,880
" " 25 to 30 " "	47—190	210—1,606

"The following table exhibits the proportion of straight and curved line, with the various radii of the curves. Number of curves, 109; number of straight lines, 110.

Length of Radius.	Number of Curves.	Aggregate Distance.
2,000 feet.	25	42,835 feet
2,100 "	4	9,802 "
2,300 "	2	3,943 "
2,500 "	5	8,139 "
3,000 "	13	20,788 "
3,500 "	6	13,781 "
4,000 "	12	25,683 "
4,500 "	2	4,990 "
5,000 "	15	45,729 "
7,000 "	2	3,656 "
8,000 "	5	15,312 "
10,000 "	8	28,100 "
15,000 "	5	21,916 "
16,000 "	1	7,139 "
20,000 "	1	8,374 "
30,000 "	2	6,920 "
150,000 "	1	26,500 "
Total,	109	293,596 "
Total length of curved line,	55 miles, and	3,156 "
" " straight line,	134 " "	3,724 "
Whole length of road,	190 " "	1,600 "

The summit is 464 feet above tide, and the level of the Ocmulgee bridge (floor) is 297 feet above tide. This bridge we take to be the western terminus of the road.

"The plan of superstructure for one hundred miles from Savannah, is as follows:

"Cross sleepers are first bedded in the ground and rammed solid, their upper surfaces being level with the grade of the road; string pieces, 6 in. deep and 12 in. wide, are then trenailed flatwise on the sleepers, and the ground rammed under them, affording a continuous bearing. On the top, and in the centre of these string pieces, is placed a small lath or ribbon, 3 by 2 in. of hard pine; and this is surmounted by the plate, or strap rail of iron, 3 in. wide by ⅝ in. thick. The iron is confined by spikes 7 in. long, passing through the ribbon into the string piece. Wrought iron splicing plates, ¼ in. thick, are placed under the joinings of the bars, the spikes passing through them. The balance of the road above the 100 mile station is similar, excepting that a light T rail is laid on the string piece, instead of the ribbon and plate rail.

"Total cost of the road, $2,581,723. This amount is made up of various items, which may be set down as follows:

"Grading, including grubbing, clearing, excavation, embankment and wooden culverts,	975,898
Culverts of masonry,	49,000
Depot at Savannah,	33,078
Depot at Macon,	24,767
Bridges, including Oconee, which cost $70,000,	126,000
Laying superstructure, and materials, except iron,	424,400
Wells, pumps and cisterns,	4,000

Iron rails, spikes and plates,	476,081
Damage by freshet of 1841,	68,000
Right of way,	36,153
Engineering, including preliminary surveys,	154,530
Motive power and cars,	168,343
Tools, machinery, etc., in shops,	15,000
Incidental expenses,	25,873
	$2,581,723

"Average cost of road per mile, exclusive of motive power, $12,702

"Since the date of my last report, we have increased our motive power by the addition of six freight engines of the second class, making our number now 14, viz: 8 third class 6 wheel engines, 5 second class 8 wheel freight engines, 1 second class 6 wheel connected freight engine; all of which are in running order, except one. These engines have performed from the 1st November, 1842, to 1st December, 1843, a total distance of 181,954 miles.

"The whole amount of fuel consumed in performance of the above distance, was 2,739 cords of wood, being an average of 66·43 miles run for every cord of wood consumed.

"Two additional freight engines, and the wheels, etc., for fifty burthen cars, have been ordered, and will be received in time to meet the business of the next fall.

"This will swell the number of eight wheel burthen cars to upwards of one hundred and fifty."

The receipts for 13 months ending Nov., 1843, were $227,531 94, of which $37,329 37 were from passengers, $17,517 76 from the U. S. mail and the remainder from freight. Number of passengers, 10,461, of bales of cotton 47,133.

The expenses for that period have been as follows:

"Repairs of the road,	61,886 89	
Tools and materials for repairs of engines and cars,	3,175 08	
Salaries,	9,885 32	
" way stations,	8,276 53	
Oil and tallow,	1,237 75	
Fuel and water,	11,477 39	
Labor, provisions and forage,	2,578 14	
Damage,	1,338 82	
Insurance on cotton,	1,352 19	
Machinists, runners and firemen,	15,194 12	
Carpenters,	2,266 67	
Blacksmiths,	1,773 78	
Conductors and train hands,	11,935 77	
Incidental expenses,	2,042 99	—134,341 43
Leaving a nett profit, of		$93,190 51

"The comptuation of profits, receipts, etc., is made up to Dec. 1st, being one month over a year, that the accounts may correspond in date with those of the bank for the future."

The receipts for the three following months, were $86,716 73.

"It will, no doubt, be observed that, in the account of expenses, the items of repairs of road is much increased over last year. We have most sensibly felt the benefit of increasing the outlay for this purpose in the improved

condition of the road, and the regularity with which our trains perform their trips.

"In order however, to show that the expense of this particular branch of the service is still within moderate limits, I may here mention that the annual cost of repairs of our road average - - $317 per mile.

South Carolina railroad, - - - - -	372	"
Georgia railroad, - - - - -	303	"
Average of eight principal railroads in Massachusetts, -	477	"
" Western railroad, - - - -	310	"

"The expense of working our road per mile run, during the above period, has been - - - - - - 73·8 cents."

HOUSATONIC RAILROAD REPORT.

We have the report of this company, dated 24th June, 1844, and make such extracts as will interest our readers. It is mainly occupied by the financial affairs of the company.

"The entire length of the Housatonic railroad, from the tide water at Bridgeport to the north line of the State of Connecticut, is $73\frac{22}{100}$ miles. In this distance there are twelve regular stations, for the receipt and discharge of passengers and freight, namely, at Stepney, Botsford's, Newtown, Hawleyville, Brookfield, New Milford, Gaylord's Bridge, Kent, Cornwall Bridge, West Cornwall, Falls Village and North Canaan. The maximum grade is 40 feet to the mile, but more than half the length of the road is passed on grades of under 26 feet to the mile.

"The following expenditures have been made in the construction of the road and appendages.

"Obtaining charter, preliminary surveys, etc., - -	6,150 32
Right of way and land damages, - - - -	60,051 43
Grading and superstructure, - - - - -	967,005 60
Engineering, - - - - - - -	24,407 23
Turntables, - - - - - - - -	1,493 64
Engine houses, - - - - - - -	4,383 68
Construction of Depots, etc., - - - - -	11,733 70
Profit and loss, - - - - - - -	46,770 53
Contingent expenses, - - - - - -	23,097 32
Real estate, - - - - - - - -	1,669 80
Engines and cars, - - - - - -	97,359 66
	$1,244,122 91

"This expenditure of $1,244,122 91, for a road of 74 miles in length, with an ample outfit of engines and cars, will bear favorable comparison with any other railroad in the United States, of similar construction."

"The Berkshire railroad company, chartered by the State of Massachusetts, with a capital of $250,000, all paid in, constructed their road from the northern termination of the Housatonic road to the village of West Stockbridge. There are four regular stations on this road—at Sheffield, Great Barrington, Van Deusenville and West Stockbridge. Its entire length is $21\frac{14}{100}$ miles. The grades are similar to those on the Housatonic road. The use of the road is granted to the Housatonic railroad company during the term of the charter, at an annual rent of $17,500, payable monthly. The road is to be kept in repair by the lessees, and in effect the Housatonic railroad company possess as complete control over it, as if it had been constructed under their own charter. The rent is paid in full, and is considered as one of the charges of monthly expense and settled accordingly. The

Berkshire company have the right to increase capital to $600,000, and an arrangement may be made for the issue of stock to an amount which may be necessary for substituting heavier rail, upon adding to the rent paid by this company a sum equal to seven per cent. upon the expenditure. This insures a superstructure equal to any which may be adopted on the Housatonic road, whenever a new and stronger rail may be laid on that road. From West Stockbridge, the line is continued to the Western road, by the West Stockbridge company, a distance of about 2¾ miles. That road is leased to the Housatonic railroad company, for the term of the charter, at an annual rent of about $1000. One half of the expense of the maintenance of the road is to be paid by the lessees. Provision is made in the lease, by which an edge rail may be laid by the Housatonic railroad company; in which case an allowance equal to one half of the average repairs of the present road, is to be made to the Housatonic railroad company."

" Receipts of	1842.	1843.	1844.
January,	$8,072 85	$11,826 87	$15,305 07
February,	6,011 75	10,212 36	15,534 03
March,	6,083 41	13,563 93	14,065 47
April	5,779 23	9,738 24	10,101 06
May,	6,363 03	10,310 64	13,142 67
Total 5 months,	$32,310 27	$55,652 04	$68,148 30

RAILWAYS IN MICHIGAN.

The rapid increase of income on these works, is truly gratifying. The Central railroad is to be opened very soon to Kalamazoo and this, the commissioners say, will itself pay the interest on the State debt.

They complain much of the heavy duty lately imposed on railroad iron.

" The tariff of 1842 placed a cash duty of $25 per ton on railroad iron, which prevented the commissioners from importing it, as they were unable to make payment of so large a proportion of the cost of the iron on its arrival in this country. The low price of iron in England would have enabled them to have imported it to great advantage had it not been for the heavy duty placed upon it, for the first time, by the act of 1842. This duty is a serious obstacle to the extension of our railroads, and the commissioners would respectfully suggest to the legislature the propriety of endeavoring to have the tariff act so modified, as to allow its importation free of duty, as heretofore, particularly for roads which had been commenced while such permission was allowed."

Of the Southern railroad they say:

" This road was ironed and put in operation to Hillsdale, 68 miles from Monroe, early in October, since which time all the locomotive power on the road has been fully employed, and a large amount of produce remained on hand at the different points on the road which it was impossible to transport in time for shipment to the east, for a want of machinery and cars. The limited means the board then had control of, not enabling them to provide in season the necessary facilities for doing all the business that was offered. Two new locomotives have been placed upon the road and a sufficient number of cars will be prepared in season, to do all the business that offers during the coming year. The difficulties which have heretofore prevented this road from producing any revenue, have now been principally overcome. The facilities for shipment of produce at its eastern termina-

tion, have much increased, and by its extension west of Adrian, the competition with the Toledo road is obviated."

The following extract from the report of Mr. Berrien, the chief engineer, is interesting. Speaking of the "warrants" in which the contractors are paid, he says:

"For all purposes except the purchase of a few things considered as cash articles, they are used to much better advantage, and being the same as cash to those who use them for the purchase of public land, a great many are induced to seek employment upon the road for the purpose of applying the proceeds of their labor, and obtaining land, which probably they could not obtain in any other way. In addition to the above is the fact that but little money is used at present in payment for labor of any kind, also helping to increase the demand for work upon the railroad, and the effect of competition has been a very great reduction in prices.

"Were money to be used we should undoubtedly be able to make more rapid progress; yet, with the exception of the time required, it is matter of doubt whether the road could be carried on to much greater advantage with money than is now being done with warrants. At any rate, there is no doubt of the fact, that the greater part of the work, and grading especially, is done at present at much lower rates in warrants than were paid for similar work, a few years ago, in cash."

ON PLANK ROADS IN CANADA.

Lord Sydenham, during his long sojourn in Russia, travelled on several of them, and found them well adapted to the circumstances and the climate; and, as both were very similar to those in Canada, he was strongly of the opinion that their introduction there would greatly conduce to the public interest. A few miles of road in the neighborhood of Toronto was first laid with plank by the local commissions who had the management of it. The cost of stone and the great, expense they had been at in macadamizing a portion of the same road, as well as the heavy annual repairs, had induced them to try the experiment in that province of laying a planked surface on the road. A gentleman describing it, says: "The few miles nearest the city, and over which very considerable traffic existed, were planked; and, upon inspection, it was found the top surface of the timber was worn in the centre for the breadth of 7 feet, and to the depth of $\frac{5}{8}$ of an inch; the ends being to the full dimensions as the plank came from the saw. The bottom or under side of the planks, was found throughout perfectly sound. In two or three places, where a small cavity was left by the foot of a horse or other animal, there was found a slight pinkish tinge corresponding with the cavity, and indicating the commencement of fungus. The sleepers appeared perfectly sound." The facts elicited by examination of the portion of the road laid down but one season, were the same as the foregoing, except that but $\frac{3}{8}$ of abrasion had taken place. From the foregoing, it will be seen—

1st. That the wear and tear of the plank road, even near a populous town, is confined to the 7 feet in width of the centre.

2d. That, for the preservation of the planks from decay underneath, it is indispensable that every portion of it be solidly imbedded in the formation.

3d. That considerably more than half the wear and tear which occurs in seven years' use of the road, takes place the first year; which is easily accounted for, by the natural stripping off while the plank is fresh, of those fibres which were cross-cut by the saw; and from the fact of the dung of the cattle getting bound with the raised fibre of the wood and thus forming

a tough elastic covering, which saves the plank in a great measure, from the effects of the horse's shoes, and the tire of the wheels. On this road the plank is 16 feet long, 3 inches thick, laid crossways at cross angles to the road, on 5 sleepers of pine 5×3 laid on edge, and in the line of the road; and this was considered the best mode of laying a plank road, except that on a country road plank 8 or 10 feet long will be found quite sufficient. On the Chambly road (plank) the planks are 12 feet long, but laid diagonally, so as to make the road but 8 feet wide. This was opposed by some, and very justly; for, as apprehended, the weight of half the vehicle and load coming suddenly on one end of the plank, and the other end not being kept down at the same time, the traffic constantly tends to disrupt the road, and the planks are loose, and spring from end to end. Another principle connected with the laying of this road, (which was opposed) is that of having the sleepers of much larger scantling than on the Toronto road. It was remarked that, as all earth formation under a road of this nature will more or less subside and shrink, the giving to the sleepers too much area would enable them to bear up the plank, leaving the earth to settle from them, thereby causing springing in the plank, which tends greatly to their being cut away; (in fact, they quickly become rounded from the edges;) and, also, that fungus and decay of the plank would be brought on, in consequence of the confined air below. These apprehensions are realized. At Quebec, part of the road has been planked, the plank being laid lengthwise of the road. It was considered that the planks would stand better the friction, and, when necessary, could be more easily taken up, and the road repaired. One strong objection to this mode of laying the plank is found to be, that the horses cannot keep their feet when much weighted, and are much exposed to falling, in consequence. Under all the circumstances, most have approved the manner in which the planks are laid on the Toronto road. Those now being planked under the department in the western section of the province are so laid, except that the planks are spiked with a 5½ inch spike—one in each end. With respect to plank roads generally, I wish none to suppose that I am an advocate for their adoption, except in those sections of the country where nature has afforded no better material, and where funds can be obtained for a better structure. There are stretches of 30 and 40 miles, in parts of the west, where the soil is a deep rich vegetable mould, and without stone or gravel of any description; in such cases you must be content to wade through the mud, or adopt the plank roads. When the traffic or intercourse of a section of country requires that good roads should be afforded for it, the adoption of plank or stone roads should be governed simply by a comparison of the first cost of each, in conjunction with the probable annual expense of repairs; and if this comparison is based on the plank lasting 12 years, (or some say 10 years,) a safe conclusion will be arrived at. In some cases in Canada, the adoption of plank instead of stone would have made such a saving as would have replanked the road every five years, if necessary. There are many sections in the west, where timber abounds, especially in Ohio, Indiana and Kentucky, where such roads might be introduced with great advantage.

GEORGIA RAILROAD.

In our last we gave extracts from the report of Mr. Thompson containing numerous details of interest to the profession, but to render the account of this specimen of civil (not political or State) engineering complete, we copy the following tables of receipts and expenditures for upwards of 6 years.

STATEMENT of the YEARLY EXPENSES incurred for WORKING the GEORGIA RAILROAD, from April 1, 1839, to April 1, 1844.

	Year ending April 1, 1840.		Year ending April 1, 1841.		Year ending April 1, 1842.		Year ending April 1, 1843.		Year ending April 1, 1844.	
	Dolls.	Dolls.	Dolls.	Dolls.	Dolls.	Dolls.	Dolls.	Dolls.	Dolls.	Dolls.
CONDUCTING TRANSPORTATION.										
Stationery and printing,	589 55		475 04		777 59		586 69		1,194 04	
Loss and damage,	1,666 93		738 67		1,909 18		382 34		2,248 48	
Incidentals,	1,101 31		883 45		1,624 68		1,866 08		1,755 26	
Oil and tallow for cars,	288 61		182 78		402 72		410 97		342 63	
Provision, clothing, etc., for negroes,	4,041 57		2,593 98		2,849 42		2,862 07		2,726 00	
Expenses of Warrenton branch,	360 25		799 43		1,062 62		591 10		772 42	
Expenses of horse car—Athens branch,					583 34		2,336 33		1,352 49	
Wages laborers,	4,522 59		2,355 11		2,022 24		3,958 23		4,111 31	
Agents and clerks,	7,467 89		7,356 39		8,742 88		9,329 42		9,289 19	
Conductors,	3,927 81		2,484 75		2,024 83		2,663 79		2,796 79	
Work done by car factory,					220 50		152 50		223 00	
Work done by machine shop.					480 00		31 50		91 00	
		23,966 51		17,896 60		22,699 97		25,170 02		26,909 61
MOTIVE POWER.										
Stationery and printing,	59 17		16 25		13 08					
Expenses of water stations,	3,009 40		2,480 98		2,518 11		2,061 12		1,963 14	
Incidentals,	70 82		27 95		329 49		184 62		255 19	
Fuel,	6,839 24		5,402 87		7,186 61		6,405 12		2,652 17	
Oil and tallow for engines,	3,108 84		1,177 54		1,538 73		1,411 34		1,459 46	
Ordinary and extraordinary repairs to engines,	6,403 38		6,792 19		9,610 28		7,866 90		5,658 40	
Improvements to engines,							2,288 00		1,632 50	
Engine drivers and firemen,	7,523 73		4,715 13		7,079 33		7,151 14		6,442 43	
Provisions, clothing, etc., for negroes.	1,503 59		[illegible] 97		1,735 42		2,852 10		2,775 00	
		28,518 17		22,652 88		[illegible],011 05		30,220 34		25,838 29
MAINTENANCE OF WAY.										
Men's wages,	12,514 12		[illegible],103 [illegible]		[illegible],549 58		18,322 73		14,862 76	
Supervisors,	1,999 94		[illegible] 36		1,733 29		2,724 23		1,694 77	
Provisions, clothing, etc., for negroes,	2,174 69		[illegible] 35		2,703 06		1,764 62		2,938 23	
Incidentals,	229 26		[illegible]0 49		524 99		809 49		1,127 66	
Tools,	414 07		377 56		826 99		399 78		715 84	
Iron and spikes,					550 47		1,969 66		1,949 43	
Wooden rails and cross ties,	1,401 17		5,446 38		11,382 80		16,046 74		14,353 07	
Repairs of culverts,							376 88			
Work done by car factory,			436 20		511 16		795 70		184 95	
Work done by machine shops.					910 17		1,474 51		366 26	
		18,733 25		21,836 61		38,692 51		44,684 34		38,156 97

MAINTENANCE OF CARS.										
Ordinary repairs,	4,936 30		4,735 20		3,660 00		2,144 37		6,045 45	
New baggage car,							1,050 00		1,050 00	
Renewal of wheels,					1,167 50		3,098 63		864 00	
Renewal of axles,							351 37		151 00	
New platform car,							2,500 00		1,565 00	
Extraordinary repairs.	480 00		189 15		1,287 00		600 00			
		5,416 30		4,924 35		6,114 50		9,744 37		9,675 45
		76,634 23		67,283 44		97,518 03		109,819 07		100,573 32

STATEMENT of the YEARLY RECEIPTS, EXPENSES and NET PROFITS of the GEORGIA RAILROAD COMPANY, from the opening of the road to the 1st of April, 1844, exclusive of charges made for transporting materials used in building the road.

DATES.	Miles road in use.	PASSENGERS.		FREIGHT.				Mail, rents and storage, etc.	Total receipts.	Total expenses.	Net profits.
				Up.	Down.		Up and down.				
		Numb.	Amount.	Amount.	Amount.	Bales cotton.	Amount.	Amount.	Amount.	Amount.	Amount.
From Nov. 1, 1837, to May 1, 1838	40	12,986	23,164 00	4,390 00	8,199 00	8,267	12,589 00		35,753 00	19,367 00	16,386 00
" May 1, 1838, to May 1, 1839	75	28,091	66,140 00	27,543 00	33,429 00	25,613	60,982 00	7,807 00	134,929 00	63,362 00	71,567 00
" May 1, 1839, to April 1, 1840	88	22,632	63,505 00	35,245 00	66,174 00	47,235	101,419 00	19,679 00	184,603 00	70,246 00	114,357 00
" April 1, 1840, to April 1, 1841	105	22,910	66,262 00	37,463 00	28,963 00	20,878	66,426 00	25,537 00	158,225 00	67,283 00	90,942 00
" April 1, 1841, to April 1, 1842	147 1-2	22,784	71,460 00	59,610 00	59,358 00	40,611	118,968 00	33,827 00	224,255 00	97,518 00	126,737 00
" April 1, 1842, to April 1, 1843	147 1-2	19,075	61,935 00	69,591 00	84,574 00	63,276	154,165 00	31,926 00	248,026 00	109,819 00	138,207 00
" April 1, 1843, to April 1, 1844	147 1-2	19,003	65,667 00	69,661 00	78,400 00	70,754	148,061 00	34,367 00	248,096 00	100,573 00	147,523 00
		147,481	418,183 00	303,503 00	359,107 00	276,634	662,610 00	153,143 00	1,233,887 00	528,168 00	705,719 00

SUSPENSION AQUEDUCT.

We are glad to learn that an aqueduct suspended by wire cables is to be erected at Pittsburgh by Mr. John A. Roebling, C. E., a name familiar to the readers of the *Journal.* The span is 160 feet, the deflection 17 feet and the total weight of trunk, cables and water, 353 tons of 2000 lbs. The strain at the points of suspension is estimated at 451 21 tons, the area of each chain is to be 27 sq. in. and the wire of which they are formed is calculated to bear a maximum load of 90,000 lbs. per sq. in.; but the greatest strain to which the cables will be actually subjected will not exceed 18,000 lbs., or $\frac{1}{5}$ of the maximum load.

The trunk will be of wood, 13·5 ft. at bottom, 15 ft. at water-line, sides 8 ft. high, all of 3 in. plank, in two courses laid diagonally, and well spiked together. The stiffness of the trunk will be sufficient to prevent vibration, even in the most violent storms and will be sufficient to support itself when empty.

A wooden aqueduct is estimated at $50,000, and Mr. R. says in a communication published in a Pittsburg paper.

"I have estimated, and I am willing, to undertake a thorough repair of the piers and abutments for	$7,000
"Adding to this the expense of the new structure, of	56,000
"And we have a sum of,	62,000

as the total expense of a suspension aqueduct, including everything."

He also very justly observes,

'There is another and a strong argument in favor of the suspension plan, which is entitled to attention. The true interest of the city, as has been observed before demands a permanent work. But the principal parts of a suspension auqeduct will be formed of iron and stone, which will last for centuries. And the wooden parts, the trunk and the beams can at any time be substituted by iron ones, so as to render the whole structure imperishable, and insure the services of the aqueduct for the future. The difference of weight by the substitution of iron for the beams and trunk in place of wood, would be in favor of iron."

The idea of carrying the Croton water across the Harlem river suggested itself to numerous persons, and we are by no means certain that it would not have been quite as safe as the present structure, at one-fourth the cost. Mr. Roebling quotes the opinions of some eminent French engineers in favor of the application of the principle of suspension to aqueducts, and appears to have thoroughly investigated everything likely to have any bearing on the success of this new and—as we think—great improvement on the ordinary wooden aqueducts of this country.

NORTHERN RAILROADS.

The railway is creeping up to the Canada lines, and we understand that a survey of a route or routes thence to Montreal is going on at this time. The line from New Haven up the Connecticut river and that from Boston across the country will ere long meet, and the question then is, shall we cross Vermont to Burlington on lake Champlain, or continue the route north by lake Memphremagog to Montreal. The distance will of course be less to Burlington, and, as this line will traverse the best part of Vermont, its receipts will be much greater than the direct line to Montreal which runs for many miles through a wilderness. The travel from Montreal to Bos-

ton will be well accommodated by either route and as the line to Burlington will receive the trade of Vermont, of lake Champlain and of the iron region of New York *in addition*, it appears to us that, in the vital consideration of income, it has very decidedly the advantage over its northern rival. Both routes have been examined, though not instrumentally. The survey now going on will give all the requisite information as to the ground on the direct line to Montreal, and though we have no hope of ever seeing a railway there we still believe that the survey now making may not be without benefit. For, if skilfully conducted, it will show whether a railway can succeed there, and, if that be impracticable, what other communication can be recommended.

But the present break in the line from Montreal to Boston and New York —we mean the distance from Saratoga to Whitehall—which has been a cause of complaint to the travelling community for the last ten years and which is likely to remain so for some years longer, prevents us from indulging in any anticipations of a good route to the north. This link is alone required to complete the communication by steam from the St. Lawrence to the Hudson, that is, from Quebec almost to Charleston, yet it is scarcely spoken of.

ENGLISH RAILWAY BILL.

Our readers will perhaps recollect that some of the arguments used against the *probable* effect of the "Railway Bill," are precisely those used by some of our contributors as well as ourselves against the *actual* effect of our New York system of "State works," in crippling private enterprize and degrading the profession. The following is from Herapath's Railway Magazine, Feb. 6, 1844.

"Shortly and quietly thus stands the case between the two parties. The government sees in the large and growing capitals of the railways and the endless offices that arise out of them, a new and vast source, from which it could derive fresh, and an almost unlimited extension of patronage, and of course of power. Garnish it how parties please, this is the simple and naked fact. No man can deny it, no one can give any other reason for the present bill. What is the case with the other or companies' side. Briefly this; they have laid out a great deal of money, have had a great deal to contend with, have hitherto received but little return, and of course now when railways are beginning to show symptoms of repaying them for their trouble, loss and anxiety, they are very anxious to enjoy the fruits of their enterprize, and the management of their property. If left undisturbed, they find they can do both with advantage to themselves and the public. They say, and very truly, "if it had not been for us, these lines would not have been made, and why, therefore, when we have risked and done so much, are we to be dispossessed of them?" That the government would not have made them is certain, for when the companies were in difficulties, and many of them in danger of being obliged to abandon their works, it would not help them with the smallest donation or even loan. Is it just then, that it should enjoy that which it neither created or assisted? That it should wrench from enterprizing individuals, the work of their hands, the moment it bids fair to repay them for their labor and risk? Where do we find a

parallel to this? Men have hitherto been allowed to reap that which they have sown, and the success of their labors has always been considered exclusively and sacredly their own. Government has never interfered with mercantile speculations, but has been satisfied with that, which it must have one way or the other, from direct or indirect taxation of successful enterprize. Private enterprize has justly been regarded as the body and soul of the prosperity of the country, and for that reason has always been encouraged, and its results respected. The present is the first instance within the compass of our knowledge, of the executive thinking to intermeddle with it. A new light has, however, now broken in upon the ministry. It is considered advisable, that her majesty should become coach-mistress-general and carrier-in-chief of the country. All the engine drivers and stokers and guards and ticket takers and clerks and porters, are to hold their appointments direct from the royal hand, and the minister of the day to have the patronage of the appointments. To accomplish so desirable an object, good old customs are to be broken through, private rights are to be trampled on and the sanctity of property violated.

"The advocates of this measure may contend that the sole object is to interfere with the future lines only. We admit that is the professed and ostensible object, but like their profession of non-interference it is all a hollow sound. The real object is the possession of all the railways, and the present are to be reached through the future. No man doubts this now, it is too clear and transparent. We have long seen and long taught it, but were not believed. Our hints and warnings were looked upon as idle croakings and therefore disregarded, but now there is but one view, one sentiment, one opinion among all men. They all see and all acknowledge that the government object is to seize the railways, not for the sake of doing good, but for the sake of the patronage, and to have the key and control of all our movements. How far this is desirable, and the use that may be made of it, may be judged of from the late creditable transactions in the post office.

"Here is one point of view in which we wish the public to consider the consequences of the State getting possession of the railways. The public has lately seen how much the sanctity of the seal is respected and if the railways get into the hands of the government, it may soon find that the boasted liberty of locomotion will be just about as much valued. It is impossible to enumerate the uses to which the possession of the railways in the hands of a jealous or arbitrary government may be turned. In times of election they would be powerful instruments in obstructing this return or forwarding that, and consequently in controlling the elections and filling the house of commons with just such members as may be wanted. We recommend the public well to look to this side of the subject before it urges on an event it may have so much occasion hereafter to repent.

"Again, with regard to the fares, the public is tickled with the notion that if the government had the railways, travelling would be much cheaper. A greater mistake never was made. It is true all the government might care about would be the covering of the expenses, and the return of the low rate of interest at which, on the State security, the money may be raised. But then the government management of everything it takes in hand is so notoriously costly, that there would be at least double the persons to do the work of the present. Men who get into government situations do not expect to work, but simply to receive their salary. What said a well paid government official to a friend of ours sometime since, who was complementing him on the goodness of his post? "There is more trouble in it, sir, than you are aware of. Besides paying a deputy I am obliged to sign

my name four times a year to receipts for my salary." Thus it is with government officials, and thus it is the expenses of everything it takes in hand are increased. It is not too much to say, that if the present railways were in the hands of the government, that the expenses of working them would be doubled or tripled. The saving, therefore, in interest would be much more than swallowed up in the expenses, and the executive, supposing it had the most cordial desire to benefit the public by cheaper travelling would be unable to do it, or if it did the chance is that the public would have to make up deficiencies by other taxes. If ministers are wise they will have nothing to do with commercial matters, and if they are inclined to, the public will act wisely to check and prevent them.

"We have an example of the expense of State management in the Belgian railways. There, though the management is under the most economical arrangement, the expenses much exceed ours, which are yet far from reduced to their minimum. What, then, would the working expenses be under our notoriously costly executive? We repeat, if the State take railways into its keeping, the public will have cause to repent it, not only as furnishing the government with a new and dangerous instrument of control but as putting into its hands matters which it would be unable to manage economically, and which would therefore, in all probability, entail upon the country a loss in proportion to its magnitude.

"But the principle of the bill is not more unjust, than are its clauses monstrous and unheard of. If, after 15 years from passing the act of any railway, its profits should exceed 10 per cent., the board of trade may lower the tolls. And if it finds it has gone too far, and reduced the profits below 10 per cent., it may elect between raising them and paying the deficiency below 10 per cent. out of the public purse. To the latter part the railways could not object; it is for the public to consider how far it is palateable to itself to pay for the board of trade errors. But here also comes in another most iniquitous clause, namely, that the board of trade is to have the sole power of deciding whether the management of the railway is economical, and to make deductions accordingly from the expenses. So that the board of trade is first to curtail the profits, and then to be sole judges of the economy of management!"

A deputation consisting of the representatives of 29 railway companies, the united capitals of which exceed £50,000,000 presented the following:

"*Statement of a few prominent reasons against the measure.*"

"This bill is objected to,—

"1. Because its provisions are not called for by any complaint on the part of the public, expressed by petition or otherwise, with reference to the matters to which it relates.

"2. Because it is introduced at so late a period of the session, and so closely following the voluminous reports and evidence on which it is alleged to be founded, as to render it quite impossible that its provisions should have sufficient considerations either by the legislature or by the parties affected by it.

"3. Because the bill (taken in connection with the reports and the resolutions therein proposed to be adopted as standing orders) is obviously intended to vest in a department of the government a power of interference with, and undue control over, all existing as well as future railways, by enabling them to foster and encourage competition in all cases where existing companies will not submit to any terms and conditions, however stringent or ruinous, which may be sought to be imposed on them; and by enabling

them also, if they think fit, to become themselves the proprietors of all new and competing lines of railway.

"4. Because such a proposal is at variance with the principles which have hitherto governed the legislature of the country in its conduct, not only towards railways but towards all similar undertakings, and would have the effect of shaking the public confidence and security for the future in all such undertakings, and in all privileges granted by the legislature.

"5. Because the exclusive application of such a bill to railways only is obviously most unjust.

"6. Because an unheard-of power would be vested by the bill in the government, giving rise to a system of private solicitation and influence, and possibly to the exercise of undue partiality, in matters which have hitherto come openly and exclusively under the cognisance of the legislature.

"7. Because there is no experience in this country to justify so great a change in the system of legislation with reference to railways, as that proposed and the experience afforded by foreign countries only demonstrates the superiority of the system which has hitherto prevailed in England, where public works, promoted by private enterprize and unfettered by government interference, have flourished to an extent unknown elsewhere.

"8. Because there is no pretence for such government interference arising out of misconduct by railway companies, or undue profits realized by them; but, on the contrary, it is admitted on all hands, that the undertakings under their charge have been admirably managed, at liberal rates to the public, and, on the aggregate, with insufficiently remunerative profit to themselves.

"9. Because, if such undertakings were vested in the hands of the government, and should prove unsuccessful, the loss which is now borne by private companies, would have to be made up by general taxation; and it is most unfair that the government, as proposed by the bill, should have an option of purchasing only those undertakings which are profitable, and rejecting those which are unprofitable.

"10. Because the power to reduce the charges of companies paying a dividend of 10 per cent. under the guarantee of maintaining that dividend, would leave the company to whom such guarantee should be granted, without further inducement to meet the public convenience, and thus, while the guarantee in case of deficient revenue would have to be made good by the public, they would be worse served than at present.

"11. Because the provisions of the bill which give immediate power to the board of trade to regulate third class trains, are inconsistent with the existing rights of railway companies, and the provisions which declare that their stations shall be open to all public conveyances, are calculated to benefit only a small section of the community, viz., the hackney cab and omnibus proprietors, to the manifest inconvenience and annoyance of all the rest of the community, and would tend to the utmost confusion, extortion and general inconvenience.

"12. Because the attempt by the government to tamper and meddle with undertakings in which property has been embarked, on the security of privileges granted by the legislature, tends to weaken the faith and security of the capitalist in those undertakings, and to induce him to embark his property in foreign speculations, to the infinite detriment of this country: and if the present attempt should prove successful, it would afford a precedent for others, directed not only against railways but against all similar undertakings."

WELLAND CANAL.

It appears that two-fifths of all the wheat coming this year from the west pass through the Welland canal, but only one-fourth of this quantity goes to Canada. Wheat for Oswego and Ogdensburg finds a shorter route by the Welland than by the Erie, besides avoiding transhipment. Our correspondent on the "Canals of Canada" has uniformly considered this as a work of more importance to New York than to Canada and the trade this year will bear out that view. Some years since, in an article on the "Spring Trade," he went so far as to place the Welland canal at the head of all routes for early freight to the west, by way of Albany, *if* the New York railways could only carry freight; and, as they now have this privilege, though to a very limited extent and with exceedingly heavy pecuniary impositions, we shall soon see whether the merchants of Boston and New York will avail themselves of the new route for early freight, via Oswego and the Welland canal, the western terminus of which is to the westward of Dunkirk, besides being on the windward side of the lake, thus offering in *late* seasons an earlier route by canal than can be furnished by any railway in the State of New York. Such at least are the views of the correspondent alluded to.

The Welland canal will however become doubly important to New York, should a drawback be allowed by our government. Then will Upper Canada receive nearly all her supplies via New York and Oswego, and the people on the borders of lake Huron will receive their spring goods some weeks before the arrival of the first ship at Montreal. Indeed that city itself may be reached via Oswego and the St. Lawrence about two weeks before that period: and, it is very certain, that the entire Upper province will be tributary to New York as soon as a little common sense can be infused into congress. Fearful odds, it will be said, but we are not without hope. Now our correspondent who is well acquainted with the trade of the Erie canal and of the St. Lawrence says that *all* the *down* freight must go by the river to Montreal and if all or nearly all the *up* freight should go by way of Oswego, what are the canals on the St Lawrence to do?

Had our Canadian neighbors built the Great Western railway from Hamilton to Detroit they would have had a work which would have yielded a surplus the first year, and which would have made us tributary to them; but there is no accounting for tastes. The following extract does not state the tolls received in 1842 and 1843. We believe they have little if at all exceeded $100,000, the interest on two millions or half the estimated cost of the canal. It was not till the year 1839 that the Erie canal had paid expenses and interest, that is thirteen years after its opening. On the other hand the four railways from Schenectady to Rochester paid from the beginning, though not allowed to compete with the canal in the transportation of freight.

"*The Welland Canal and its Business.*—The Buffalo Commercial of Saturday gives this description of the Welland canal and of its business in the transportation of American produce.

"The work is 38 miles long 10 feet deep, and has a large number, some forty locks to overcome a rise of 360 feet existing between Port Dalhousie on lake Ontario, and Port Colborn, on lake Erie.

"The total business of the Welland canal for 1840 and 1841, was

		1840.	1841.
Flour,	Bbls.	186.864	193,137
Beef and pork,	"	14,889	24,195
Wheat,	bush.	1,720,660	1,212,460
Corn,	"	27,088	90,160
Staves,		1,623,000	2,725,000

"Among the items going towards the west, were—

Salt,	bbls.	153,030	149,337
Merchandize,	tons	2,770	3,718
Tolls received,		£18,037	£18,583

"The quantity of a few leading articles exported from the port of Cleveland alone, throguh that channel, was—

		1842.	1843.
Wheat,	bush.	380.684	90,689
Corn,	"	59,670	78,481
Flour,	bbls.	94,248	49,360
Pork and beef,	"	40,098	5,000
Total value of all exports,		$1,017,000	$357,400

"This season the shipments from Cleveland have been very heavy, and will doubtless exceed those of 1842.

"A partial and satisfactory view so far as it goes, may be had of the extent of the shipment by the Welland canal this season, obtained from the St. Catharines, W. C., Journal:

"The amount of wheat entering this season at Port Colburn up to the 22d July was 865,024 bushels, of which 657,429 bushels were for Oswego and Ogdensburgh, and the remainder as follows—

	St. Catharines.	Kingston.	Grananoque.	Total.
Wheat bushels,	09,329	57,507	50,799	207,655

the duty on which at 9 cts. a bushel, amounts to £4,672, which, added to the sum collected on flour, pork, and other products, cannot fail to give an increase of revenue far beyond any former period. This exhibit must be of considerable interest to the trade, and we shall look with much anxiety for further movements."

Since the above was in type, we have seen in the papers an article from the St. Catharine's Journal in which the editor says:—

"*Welland Canal.*—In our last number we gave a brief statement of the unprecedented and rapid increase of the trade of lake Erie, and the small proportion of it as yet secured for Canada, by the St. Lawrence. But we have no doubt that the efforts now making—by the improvement of our water communications—to divert this commerce into its natural channel, will, ere long, be crowned with success."

Did not our modesty interfere we would recommend our Canadian neighbors to take the Railroad Journal, when they would no longer talk such nonsense. The "natural channel" is that which takes the wheat where it is wanted and the wheat passing via the Erie canal is for consumption in this country. There are of course a few hundred thousand barrels shipped

to South America, England and the West Indies, but not enough sensibly to affect the income of the Erie canal. Now how is the million of barrels shipped to Boston to reach that port via the St. Lawrence? It has already been explained over and over again, that the trade via the St. Lawrence is in *addition* to that of the Erie canal, and the insignificant amount of produce taking the former route shows the smallness of the demand in Montreal and is in no degree influenced by the cost of transportation from lake Ontario to Montreal—30 to 35 cts. per barrel—an amount insufficient to affect the demand to any extent. Were flour carried now for 15 cts. per barrel from Kingston to Montreal it would not add one hundred thousand barrels to the trade of the St. Lawrence. But twelve years unremitting attention to these matters has taught us the almost impossibility of projecting works to be executed at the expense of the public with any degree of intelligence and skill, or conducting them with the economy, order and method so necessary to insure success. *As long as the money holds out* the political adventurers will cry out for more and backed by their political engineers *will succeed* as they have in New York, in saddling the people with an enormous debt and a lot of preposterous works, such as the Chenango, Black river, Genesse valley canals and the enlargement of the Erie, on which 20 millions have been spent and which will require 20 millions more to complete them, the interest to be paid by taxation.

BEAUHARNOIS CANAL.

Some astounding developements have taken place with reference to this portion of the St. Lawrence canal. Those of our readers who see the "Civil Engineer," the organ of the profession in England, may recollect an article from the pen of Mr. Casey, on the "Canadian Board of Works," (Feb. 1843,) in which he places their integrity on a par with their capacity. We now see it openly announced in London that a notorious personage of the name of *Wakefield*, who figured some 16 years since in a most infamous abduction case, was paid $60,000 for securing the construction of the canal on the south bank of the St. Lawrence, through the property of a company at one of whose meetings the above statement was made by the directors! Log-rolling is nothing to this. We console onrselves to some small extent with the idea that the profession is not responsible for this barefaced bribery. That is, we hope that the Engineer, Mr. Hamilton H. Killaly, through whom this was effected, will turn out to be no engineer at all. Indeed we do not see how it is possible that he should be, when neither the Editor nor the readers of the "Civil Engineer" have answered Mr. Casey's inquiry of September last as to the standing of Mr. K. in his own country. Within a few days we have seen one of his most important papers and such a document never emanated from any *other* engineer—if he be one—as all will admit who see this extraordinary production. Taken in connection with the $60,000, the "modus operandi" of placing the canal on the south or Beauharnois side is traced with a pencil of light.

But we will always show fair play, and if any of our readers can refer us to any canal or railway in England or Ireland, however small, constructed under the direction of Mr. H. H. Killaly, we will cheerfully insert an account of it in our columns and thus answer in part Mr. Casey's advertisement of Mr. K. (for such it is) in the "Civil Engineer," the readers of which Journal are obviously at fault, though they of course comprise the entire profession in England and Ireland, and though Mr. Killaly speaks of his "long professional career." They certainly *ought* to be known to each other. We may perhaps introduce Mr. K. to the profession in the United States in another number by means of some extracts which, our readers will be forced to admit are somewhat different from anything they have ever seen.

PRINCE DE JOINVILLE'S PAMPHLET.

The Prince's pamphlet on the importance of a steam navy to France is published at length (translated) in the Civil Engineer's Journal for July. The editor very truly says that the Prince is a person of much common sense when he pleases and—when not speaking for "Buncombe" which is pretty nearly the American for "young France"—the tone, style and manner of investigation are those of a truly practical man, well versed in his profession and who has given much attention to the higher departments of the service. It is of interest to us as showing the important part which the civil engineer is to play in another war, and, still more so from the great stress which the Prince lays on the importance, indeed the necessity of encouraging private enterprize and not trusting to government establishments the difficult and complicated machinery of men-of-war steamers. We make a few extracts.

"One fact of immense import, which has been accomplished of late years, has given us the means of raising our fallen naval power, and of making it re-appear under a new form, admirably adapted to our resources and national genius.

"This fact is the institution and progress of steam navigation.

"Our navy could only be an artificial creation when the empire of the sea belonged to the one who put afloat the most seamen. Our ruined mercantile navy no longer furnished us seamen enough; we should have vainly struggled to avenge affronts, to efface melancholy remembrances; but when even temporary success had attested the courage of our seamen, numbers would in the end have stifled our exertions. The steam navy has changed the face of everything; now it is our military resources which are about to take the place of our impoverished naval personnel. We shall always have enough officers and seamen to perform the part still open to a seaman on board a steamer. Machinery will supply the place of hundreds of arms, and I need not say that we shall never want money to construct engines, still less that we shall never want soldiers when the honor of the country is to be maintained.

"With a steam navy, the most audacious war of aggression is permitted by sea. We are sure of our movements, unshackled in our actions. Time, weather, tide, no longer disturb us. We can calculate to the day and hour."

"In all, England now reckons one hundred and twenty-five steamers

Of this number, seventy-seven are armed, and to these must be added two hundred steamboats of superior quality, fit for carrying heavy guns and troops, which the merchant navy could furnish to the State on the very day they were wanted.

That is not all: to form an idea of the real force of this steam fleet, we must have seen close at hand how formidable its equipment is, we must have seen the care and skilful foresight with which everything has been designed. The English war-steamers have not been designed warranted good for every kind of service without distinction, in their construction only one idea, one end has been in view—war. They conjoin with a marvelous fitness for sea purposes, high speed, powerful artillery and plenty of stowage for passenger troops."

"What they particularly wanted was to be employed on stations where they could be put in comparison with foreign vessels. This inconvenience together with the prejudices exclusively prevailing in favor of the sailing navy, was the reason why the progress of our steam fleet from 1830 to 1840 was so nil. Science however had progressed. The royal navy of England having leisure for experiments, and further, having under its eyes a merchant steam navy in which number and competition produced daily progress, turned out some magnificent vessels."

"By an excess of foresight too common with us, the administration has thought fit first of all to create repairing establishments for the new navy. In all our ports now rise magnificent factories enclosed in stately monuments. These factories are for the purpose of repairing the damage, and providing for the wants of the steam navy, and this navy is only in its infancy.

"However as these large factories cannot be left without employment nor the workmen without work; as besides in the nature of things, all the steamers we have are employed at Toulon, and that there are only steamers to repairs at that place, what has been done with the factories constructed in the ports of the ocean? They have been employed in manufacturing engines, instead of giving the contracts for them, as a premium to private industry.

"We had already Indret and its costly productions. Was it necessary to add to this luxury of establishments? Was it requisite to employ the money destined for the increase and improvement of the fleet, in raising monuments of which the immediate utility is far from being demonstrated?

"We have always been inclined to increase without limit the immovables of the navy, to the detriment of everything efficacious and active in the department. It would be good to try the other plan, and I am convinced that we should readily find the means of arming a true steam fleet and encouraging a useful trade, by requiring from private establishments, fine and good machines, such as they know how to produce.

"If I were here to trace the true state of our steam navy, if I were to say that of this number of forty-three steamers afloat borne on the budget, there are not six fit to compare with the English vessels, I should not be believed, and I should still have asserted the strict truth. The greater number of our vessels belong to that class good in 1830, when they were turned out, but now, most certainly much behind present improvement. These vessels subjected in the Mediterranean to a navigation without repose, have almost all reached a premature old age. As I pointed out just now they are no longer sufficient for the service of Algiers and the political missions on which they are sent, for want of better vessels. The officers who command them blush at seeing themselves weak and powerless, I will not say

alongside the English only, but the Russians, the Americans, the Dutch, the Neapolitans, who have better steamers than ours."

"Perhaps the use of the screw, by leaving the steamer all the power of a sailing vessel, will some day produce a change in the state of things. Steam will then become a powerful auxiliary to our cruisers, but this alliance of sail and steam would change nothing as to what I have before laid down. The steamer destined to serve in squadron or on our coasts, should always have a high speed, by steam alone, as the first means of success."

Omitting the appeals to the worst passions of the French, their "love of glory" as they call it, but their insatiable desire for plunder as it is only too well known to be by most nations and certainly by the American commercial marine, omitting this which the Prince has probably introduced as a matter of necessity rather than of taste, we think his views compare very favorably—indeed they completely overturn the position of the spirited but unfortunate Captain Stockton, who had the egregious vanity to imagine and even to announce, just before the terrible disaster at Washington, that the discoveries and improvements introduced in the Princeton would change the entire system of naval warfare and would put the weakest nation on the ocean on a level with the most powerful! The Prince shows, though he does not admit it, that steam has actually increased the relative power of England, and it is easy for us to gather from his statements that, in six months, the United States would be more than a match for France, as regards *steamers*, owing to the skill and immense capabilities of our private engineering establishments.

HERAPATH'S RAILWAY MAGAZINE.

We are indebted to some kind and attentive friend—for such we must consider him—for copies of this spirited periodical, immediately on the arrival of the steamer. We have in this number an article on "Railway Legislation" and can give no stronger proof of the accuracy of the editor's views than, that all and more than all the evils he anticipates from the interference of the government *there*, are matters of fact *here* where the States have taken works into their own hands. In our next we may recur to this subject, to which we devoted much attention some time since. Indeed a long article was copied from the *Journal* into the III volume of the "Civil Engineer," in which the unhappy effects of government engineering were pointed out and where the editor of Herapath's Railway Magazine will find some of his worst suspicions borne out by our experience. There is little probability that any new works will be undertaken by the States, and at this moment Canada stands alone as the advocate of the "system" which, in the case of the Beauharnois canal, they have certainly carried out with great additions if not improvements. On the other hand, private enterprise here is recovering from the effects of its long struggle with the State governments and railways are rapidly extending themselves in all directions. Indeed all we ask is to be "let alone," and the country will soon have railways and canals of the first order wherever they are required, and that too

without either the taxation of New York and Canada or the repudiation of Pennsylvania and Michigan.

OPENING OF THE LONG ISLAND RAILROAD TO GREENPORT.

On Saturday, Aug. 3d, the officers and directors of this company with a very large number of invited guests, among whom were the corporations of New York and Brooklyn, most of the notabilities of Long Island, Jas. De Peyster Ogden, prsident of the chamber of commerce, the officers and directors of the New Jersey railroads, and very many other citizens, amounting probably altogether to some five hundred persons, made an excursion to Greenport and back to this city.

The party left Brooklyn at 8 o'clock in three trains of cars; the leading train making only two stops, arrived at Greenport in 3 hours and 35 minutes; 6 minutes were occupied in taking on wood and water, thus reducing the the time occupied in running over the distance of 95 miles to 3 hours and 29 minutes. The engineer expressed an opinion that with the new locomotive now building by the company he will be able to run over the road in less than 3 hours.

Time occupied in running from Brooklyn to Jamaica 23 minutes, distance 11 miler.

	Hours.	Minutes.	Miles dis.
Hicksville,		56	26
Farmingdale,	1	6	31
Stopped for wood and water,		3	
To Deer Park,	1	21	37
Thompson station,	1	31	43
Suffolk station,	1	35	46
Medford station,	2	1	55
Carman's river,	2	13	61
St George's Manor,	2	27	66
Stopped for wood and water,		3	
Riverhead,	2	48	74
Greenport,	3	35	95

We should be pleased to give an account of the grades, curves, stations, engines, cars and cost of the road, such as is given of the Central road in this number. The trains now run daily to Greenport and the distance to Boston by this route is accomplished in about 10 hours. The company are constructing a tunnel in Brooklyn in order to dispense with the use of horses. They go now thirty miles an hour with sixteen ton engines. A pretty severe trial to any track and a speed they will find it difficult to keep up.

The number of passengers taking this route is very great and we only hope our anxiety for its success has made us overrate the difficulties to be overcome in order to maintain an average speed of 30 miles per hour.

RAILWAY SPEED.

In our last week's impression, we gave a circumstantial account of the opening of tha Darlington and Newcastle railway, which completes the line of communication between the latter town and London. The special train which conveyed a party of directors and friends from London to Newcastle on that occasion, accomplished the journey, 303 miles, in the short space of nine hours and thirty-two minutes, being an average of about thirty-two miles an hour, including stoppages; but as this naked statement

would supply a very inadequate idea of the actual rates of progress on some parts of the line, we now give a tabular view of the performance. The train left the Euston square station at 3 minutes past 5 in the morning and reached Newcastle at 35 minutes past 2 in the afternoon. The following are the distances on the respective portions of the line, the time consumed in passing over each, and the rate per hour run:—

	Miles.	Hours.	Minutes.	Rate pr. hr.
London to Rugby (Birmingham line,)	83	2	11	38 miles.
Derby, (Midland Counties,)	49	1	22	36 "
Northampton, (North Midland,)	63	1	28	43 "
York, (York and North Midland,)	24	0	37	29 "
Darlington, (Great North of England,)	45	1	13	37 "
Newcastle,	39	1	20	20 "
	303	8	11	

Average 37 miles an hour.

The remaining time, 1 hour and 21 minutes, was consumed in stoppages. Of course, it would not have been prudent to run over the newly opened portions of the line at much more than the ordinary speed; but the rate of progress upon the older portions, considering the distance, is really astonishing, that on the North Midland especially; and we believe the performance altogether is quite unprecedented.—*Leeds* (*Eng.*) *Mercury.*

BEAUHARNOIS CANAL, AGAIN.

Little did we think when penning our brief article on this canal that we should so soon find such remarks as the following in a Canadian paper.

"It was our intention to have occupied our leisure during these dull times with an exposure of that most horrible and scandalous of all jobs, the Beauharnois canal, having acquired information to an extent never dreamt of by the guilty parties concerned in the nefarious business, but the truth is, we *dare not.* The *various participators* in the lare bribe of £12,500, occupy *too high a station in office and society to be safely exposed,* even when a journalist is doing a public duty and has truth on his side. Nothing but a committee of the Legislative assembly can bring this iniquity to light."—*British Whig, Kingston, Aug.* 9, 1844.

NORWICH AND WORCESTER RAILROAD.

For July, the increase of income on this route has been $9326, or about 75 per cent. over July 1843; and in the first seven months of this year, the gain has been $40,000, or 25½ per cent. This greatly exceeds the ratio of gain on the Western, and if continued through the coming five months, will, by December 31st, amount to $85,000, and added to the surplus of last year over interest and expenses (which was $25,000) will give a net revenue of $110,000, or nearly seven per cent. on the capital stock, and will leave a reasonable reserve fund besides.—*Bost. Trans.*.

CONTENTS:

AMERICAN RAILROAD JOURNAL, AND MECHANICS' MAGAZINE.

Published Monthly at 23 Chambers-st. New York, at $2 a-year, in advance, or 3 copies for $5. | D. K. MINOR, Editor.

No. 10, Vol. 2, Third Series. | OCTOBER, 1844. | Whole No. [illegible] Vol. XVII.

READING RAILRAOD.

Much has been said, written and published in relation to this railroad, and its managers. Bold predictions have been made in relation to its durability under the trade which it is destined to bear; and as to its ability to compete successfully with the canal for the coal trade. From some cause, to a stranger wholly inexplicable, there exists in the minds of many of the wealthy citizens and business men of Philadelphia, a strong prejudice and opposition to the work. If doubts of its success, or predictions of its failure, or even curses loud and long could have suspended its progress, it would now be numbered among the things that were; and notwithstanding the great benefits which it has already conferred, and will hereafter confer, on the *coal consuming* community, there are thousands who would rejoice to have it prove a total failure. It is to be hoped, however, and it is confidently believed by those who look at it with a favorable eye, that its success is certain.

This work was projected and commenced during a period of great prosperity—but like many others, it was overtaken, before completion, by a general depression of trade and unparalleled derangement of the financial affairs of the country; and, but for the most determined perseverance and energy of its friends, it would probably have been suspended before it reached the coal region, thereby rendering the part completed in a great degree valueless. This, to many, desirable result, was avoided, and by great effort the road was opened to the coal region in 1842, in which year 40,000 tons and in 1843 230,000 tons of coal, besides other freight, passed over it. This year the coal tonnage will not fall much if any, short of 450,000 tons, which will make the aggregate of tonnage over the road since its completion about equal to 1,000,000 upon the single track mainly. In consequence of having but one track completed it has been necessary to keep up a higher rate of speed, with the coal trains, tran is considered proper, which has been to some extent injurious to the rails; yet, on an examination much on

we were able to give, at the various stopping places in passing twice over it, we are of the opinion that most of the rails now in use on the first track will sustain a further tonnage two or three times greater than has already passed over them. The second track, more than half of which is completed and the remainder in a state of forwardness, which with six new locomotives of great power, and a large number of new iron cars of improved construction, will enable the company to increase their business largely this fall, and to be in readiness on the commencement of business next year to work at much greater advantage and economy than they have hitherto done.

The new track is laid with a rail of 60 lbs. to the yard, and of much better form than that first laid down, having at least double the thickness or amount of metal, in the *tread*, thus giving it greater strength and durability.

The new cars are of iron throughout, and of capacity to contain *five* tons instead of $3\frac{1}{3}$—the capacity of the wooden cars—and of superior form and construction, having springs at the connection, thereby relieving them to a considerable extent from the effects of the shock in starting the train, which is very severe when the train consists of *one hundred* cars with 375 to 400 tons of coal, which is now a common load for the new engines.

The company have now a good supply of locomotives of various kinds, many of which have been considered of great power; one made by Messrs. Baldwin, Vail and Hufty, took a train of 100 cars, or a gross load of 481 tons in February 1841, and another the "Monocacy," from the New Castle Manufacturing Co., took 100 cars with 335 tons of *coal* at a load. These and others in use on the road, have been considered superior engines —but those recently put on, the "United States," the "New England," the "New York" and the "Ontario," from the manufactory of Messrs. Baldwin and Whitney, surpass any, it is believed, that have heretofore been constructed in this, or any other country. They are called 16 ton engines, but are somewhat heavier, and are on six wheels, 46 inches diameter, all connected as drivers and all in front of the fire box. Cylinders 15 inches diameter, and 18 inch stroke. The boiler has 137 tubes 12 feet long, $1\frac{3}{4}$ inch diameter. The calculated maximum load 750 tons—which one of these, the United States, has performed repeatedly, it is said, during the months of July and August; and with such ease that it is estimated that she will haul on a level 1000 tons, gross.

The company are also extending their wharves and depot at Richmond, on the Delaware, so as to accommodate a large business. Last year and the early part of this, they could accommodate and load at the same time, from 15 to 20 vessels, and by the opening of next season they will be able to load 30 to 35 at the same time; which, with the completion of a new branch road, from Mount Carbon, ten or twelve miles up the valley of the Schuylkill and a connection with the Little Schuylkill railroad at Port Clinton, by which a large additional trade, now given entirely to the canal, for want of connection with the railroad, will ensure a vast increase of bu-

cheese next year. Indeed they are now, in their unfinished condition, with but a track and a half, short of cars and locomotive power, performing more labor than *any other railroad* in the world! They are at this time hauling over 100,000 tons, *one mile daily*. Where is the other road doing so much? In a few weeks it will be increased to 200,000 tons; and next season to a much larger amount, and at rates much lower than have ever been known before; thus reducing the cost of fuel to a large section of country on the sea board, and along the navigable rivers and canals, to an amount not less than one and a half or two millions of dollars a year—which, in five or six years, would reimburse its entire cost—and contributing to the comfort and necessities of millions of people, and yet we find a greater hostility existing against it in its vicinity than to any other work in the country—to be accounted for, probably, on the same ground that the introduction of *improved machinery* is often resisted in the manufacturing districts, by the operatives—but in this case as in those, experience is sure to effect a change of feeling in the public mind; and the Reading railroad is destined to become one of the most successful enterprizes of the age.

BALTIMORE AND SUSQUEHANNA RAILROAD.

The enterprizing citizens of Baltimore, in their efforts to secure their full share of the western trade, have accomplished more in the way of *roads and railroads* than any other equal amount of population in this country except Boston. Before the era of canals and railroads, their turnpikes were at least equal, if not superior, both in extent and character, to those emanating from any other city of equal population in the Union: and when New York had completed her great canal, and Pennsylvania had commenced her improvements, Maryland, or rather *Baltimore*, dashed boldly into the then almost untried railroad system, and commenced two distinct lines, the Baltimore and Susquehanna and the Baltimore and Ohio railroads, for the accommodation of the western trade. From thus dividing her forces many difficulties have arisen, and, although much has been accomplished, the great object in view, viz. to reach the waters of the Ohio river, has not yet been attained; of course all the advantages anticipated from the outlay of so much capital have not been realised.

The route adopted by the Baltimore and Susquehanna railroad company had many obstacles to be surmounted, including two summits besides much of the way laying through deep ravines, requiring many sharp curves and a greater number of bridges, we believe, than on any other road in the country, there being over 80 bridges in 57 miles, to York. It was undoubtedly the intention of this company to turn in a westerly direction after crossing the Pennsylvania line and thus reach Pittsburgh by a continuous railroad; but not being able to accomplish that desirable object they directed their course towards Columbia, on the Susquehanna, where they connect with the Pennsylvania works,—the canals westward and Columbia and Philadelphia railroad eastward and thus open an easy and pleasant communica-

tion between Philadelphia and Baltimore; and although the distance by this route is somewhat greater between the two cities than by that through Delaware, yet to those who travel to enjoy delightful scenery we would heartily recommend the route, by York, Columbia and Lancaster either going or coming, and thus enjoy the pleasure of passing through some of the most highly cultivated regions and beautiful farms of Pennsylvania, and at the same time through some of the wildest and most picturesque valleys in Maryland. Leaving Baltimore at 9 o'clock A.M. the cars arrive at Philadelphia at about 7 P.M. Fare, $2,50 through.

When in Baltimore a few weeks since, we were, through the politeness of the president of the company, invited to accompany the directors over the road to York and Columbia, which enabled us to form some opinion of the extent of their operations, their system of police and the character of their engines, cars, etc.

On leaving the offices in North street, the cars are moved by horse power for more than a mile, until they arrive at the main depot and machine shop, quite out of the city. Here an exchange of horses is made and one of iron taken. The locomotives of this company are of an efficient class; taking heavy loads over their 80 feet grades, with great ease; but of these we hope to be able to speak more definitely hereafter. Their cars are of a superior description. The passenger cars have one safeguard quite new to us and which we would earnestly recommend to other companies, and especially to those who use the flat bar rail. They have put an *under floor* of inch oak boards to all their passenger cars, which will prevent accidents from "*snake heads*," from which some sad ones have occurred in this country. The cost is but trifling, yet the security afforded to the passengers, we are induced to believe from our own observation, is sufficient to render its adoption *imperative* on every flat bar road in the country.

The freight cars in general use on this road are superior, in many respects, to any we have seen, that is, they carry a greater amount of freight in proportion to the weight of the car, than on most roads. They have six wheels, the body is made light but strong, resting on *wood* springs, consisting of two pieces each 2 inches by six, and 13 feet long, of white ash plank. Other companies will do well to examine them and either adopt, or improve upon them. The success of railroads will depend much on the introduction of improvements in the various details in their management; and in no one particular is greater economy to be introduced, perhaps, than in the weight and construction of cars; many of those now in use are altogether too heavy in proportion to their capacity, especially on the Pennsylvania roads where the State furnishes roads and motive power and the forwarders own the cars or *section boats*, in which about *two* tons of freight are carried for *three* tons of dead weight, or car!

The charge for freight on merchandize, produce, etc., on this road is, from Baltimore to Columbia, 75 miles, $1 12½ per 1000 lbs., and on plaster 80 cents. The police of the road appears to be excellent. We have a-

opy of the regulations before us which appear to be well arranged to insure safety, if followed, and the best evidence that they are attended to, in our opinion is, that very few accidents have, as we are informed, occurred on the road.

PAPERS ON PRACTICAL ENGINEERING: NO. 2.

A special report on the Sea Wall, built in the year 1843, for the preservation of Ram Head at the northwest end of Lovell's Island, in the harbor of Boston, Mass., by Col. S. Thayer, *U. S. corps of Engineers.*

We are indebted to a friend for a copy of No. 2, of these most welcome and unexpected papers. The great variety of work executed under the superintendence of the U. S. engineers, the scientific acquirements of the corps and the circumstance of their having leisure to investigate and calmly note down the numerous details of construction so interesting to the profession, lead us to anticipate much good from the publication of these papers. Our readers are acquainted with the papers published by the Royal engineers to which, as well as to the Transactions of the Institution of Civil Engineers, their costly mode of publication is a most serious objection. The present number is by an officer as well known as he is highly esteemed.

By an act of congress, passed March 3d, 1843, the sum of $16,000 was appropriated for a "sea wall on Lovell's island, Boston harbor." The part of the island intended to be secured is called Ram Head, a small remnant of one (the northwestern) of the two eminences originally forming the island, or rather, probably separate islands, until in process of time, the water course between them became filled up by the debris proceeding from the destruction of the former. These debris, consisting mostly of very coarse gravel and pebblestone, have moreover been driven southerly in the direction of Gallop's island, and pushed far into the main channel, leaving the present width of the channel at this place about two hundred yards. These changes, viz: the abrasion of the island, and consequent invasion of the channel, have been steadily advancing up to the present time, and so rapidly of late years, as to render it almost certain, that the latter would be closed at no distant period, unless the evil could be arrested by the preservation of Ram Head. Such was the origin and object of the work about to be described.

The topography of the site, and the position, form and dimensions of the sea wall, generally, are exhibited in the sheets of drawings herewith submitted. The levels are referred to the plane of (extreme) low water, corresponding to that of the map of George's island, executed by Col. Kearny. The beach, to the distance of several hundred feet, and in some directions to a much greater distance from the wall, is a little above the level of half tide; varying from seven to ten feet above the plane of reference. It consists of pebbles embedded in hard clay, and is protected from further abrasion by the large stones (boulders) covering its surface, probably remaining near where they fell from the bank as it receded, being too massive to be swept away by the sea. This beach may therefore be considered as permanent.

Above the foundation, which consists entirely of beton, the wall is faced up to the coping with blocks of granite in regular courses of about two feet each in thickness or rise. Every course consists of headers or stretchers placed alternately, their dimensions being as follows, viz:

Headers.—None less than four feet, or over five feet long, average about 4′ 8″; least width two feet, average width 2′ 3″; the widths being measured on the narrowest heads, which are always in the face of the wall.

Stretchers.—Length.—None less than six feet; average length about eight feet. *Width.*—No bed less than two feet.

The stretchers are so jointed, as to be three inches longer on the back than in front, thereby forming a dovetail joint with the headers. These last, being widest in rear, are thus also kept in place by the backing of the wall, which is composed wholly of beton. Thus all the materials of the wall are inseparably connected by a system of dovetailing.

The entire beds and joints are hammered full, and laid in contact, stone to stone, the cement mortar in which they are laid only filling the small cavities between the *touching points.*

Headers, two feet in thickness, in part five feet, and in part 4′ 3″ long, and averaging 3′ 9″ in width, constitute the coping course.

The number of stones in the wall (headers, stretchers, quoins and caps inclusive) is 902, amounting, when hammered, to 901·85 cubic yards, or a cubic yard each on a general average.

The width of the wall at the upper surface (on which the coping rests) is 5′ 6″, and the average width, including the foundation, is about six feet.

There are in the foundation 540·5 cubic yards, and in the backing of the superstructure 795·7 cubic yards, altogether 1336·2 cubic yards of beton, which added to the granite facing and coping above stated, make the contents of the wall 2238·07 cubic yards.

Cost of Masonry.

Stone in the rough,	\$4097·21 + 901·86 =	\$4·54307		
Mortar materials,	175·26	"	0·19433	
Dressing,	2585·08	"	2·86639	
Laying,	567·74	"	0·62952	
Machines and tools,	404·09	"	0·44806	
Receiving and hauling materials,	338·02	"	0·37480	
Total cost per cubic yard,				\$9·05617

Foundation Beton.

Mortar, 6·17 cub. ft.	Cement, 256·37 pounds = 3· cub. ft. stiff paste,		\$1·2820
	Sand, 674 pounds = 8·2 cub. ft. loose = 6·75 cub. ft. perfectly compact,		0·1715
Gravel, 25·13 cub. ft.,			0·2397
Making mortar,	0·0647 days	0·2595 days	0·3064
Mixing beton,	0·1290 "		
Transporting do.	0·0545 "		
Packing do.	0·0313 "		
Tools, implements, platforms, runs, hauling sand, etc., etc.,			0·1121
Total cost per cubic yard,			\$2·1100

Backing Beton.

9 cub. ft.	Cement, 281½ pounds = 3·28 cub. ft. stiff paste,		\$1·4065
	Sand, 741 lbs. damp = 9 cu. ft. loose = 7·2 cu. ft. compact,		0·1592
Gravel, 24·1 cubic feet,			0·2296
Making mortar,	0·0648 days	0·3178 days	0·3753
Mixing beton,	0·1214 "		
Transporting do.	0·0555 "		
Packing do.	0·0761 "		
Tools, implements, platforms, etc.,			0·1121
Total cost per cubic yard,			\$2·3120

Average cost of the whole beton (foundation and backing),

$2981·35 ÷ 1336·4 = $2·2310

Entire Cost of Masonry.

Stone work,	901·86	*at*	$9·05617	$8167·40
Beton,	1336·21	*at*	2·2312	2981·36
Total,	2238·07	*at*	4·9814	$11148·76

A batch of mortar was composed as follows:

Cement = 1 cask 321¼ pounds (average) = 3·75 cubic feet stiff paste.

Sand = two wheelbarrow boxes heaped = 845⅝ pounds damp from heap = 10¼ cubic feet loose = 8¼ cubic feet reduced to minimum bulk.

This dose of sand was about 50 per cent. greater than would have been used in mortar for ordinary masonry, or for beton in caps or arches. The result of the mixture was 10¼ cubic feet of stiff mortar = 11 cubic feet in a limber state, such as when used. There were made in all 1128 batches = 1128 × 10¼ = 11562 cubic feet = 428·22 cubic yards, costing as follows:

Cement = 362·400 pounds *at* ½ cent,	1812·00
Sand = 476·92 tons *at* 51 cents nearly,	243·24
Labor, including transport of mortar to beton bed, average distance 40 yards = 86·5 days,	102·33
	$2157·57

Cost of cubic yard of Mortar.

Cement = 846·06 pounds = 9·9 cubic ft. stiff paste,	4·231
Sand = 1·11373 tons = 27 cubic ft. loose = 22¼ cubic ft. perfectly compact,	0·568
Labor = 0·2019 days,	0·239
27 cubic feet *at* 18⅔ cents,	$5·038

The mortar was made by hand, in a box 7′ long, 5′ wide, and 11½″ deep, which had been constructed for a different purpose, but answered sufficiently well for this. One half of the sand was first put in and spread, then a cask of cement, and over this the remainder of the sand. The water (salt) was then added, and the mixture effected in the usual way by two men, to whom a third man was occasionally added.

The batch of mortar above described = 10¼ cubic feet was mixed, for foundation beton, with eight barrows full of shingle = 31½ cubic feet and for backing beton, with 7 barrows full = 27½ cubic feet. With respect to the latter, however, it is to be remarked that the whole of the mortar was not mixed with the shingle, a certain portion, say about six per cent., being applied to the surfaces in contact with the beton in the wall. The shingle was of every size from that of a pea to pebbles of 6 inches diameter, and the different sizes so proportioned as to give a minimum void. Although this void was not accurately ascertained, yet, judging from experiments with other materials not dissimilar, and from the bulk produced by the mixture of given quantities of the shingle and mortar, I feel safe in stating it at somewhere between 20 and 25 per cent. of the volume of the shingle.

The process of fabrication was briefly as follows:

The shingle having been brought in wheelbarrows from the pile or depot near by, and spread on the platform (formed of rough boards) in a layer from 8 to 12 inches in thickness, (according as the materials are more or less coarse) the finest shingle at bottom, and all the pebbles at top, the batch of mortar is spread over it as evenly as possible. The mixture is effected by four men, viz: two with shovels and two with hoes, the former facing each other, and each commencing at a corner of one of the sides of the pile, work from the exterior towards each other, until they meet, throwing

each shovel full so as to form an irregular ridge, the commencement of a new pile, at a convenient distance on one side. They then step back and recommence a new section (the width of the shovel) and operate in the same manner depositing this portion by the side of the other, until the whole mass is turned and formed with the aid of the hoes into a heap similar to the original. As each shovel full is turned up and spread, or rather scattered by a jerking motion, it is seized by the hoe and brought into proper form and position being thereby more intimately mixed. The heap is again turned in like manner, but in the opposite direction, when the mixture is complete, all the surfaces of the shingle being well covered with mortar.

It is scarcely necessary to observe, that the success of the operation depends entirely on the proper management of the tools, which, although not a difficult act, is seldom attained without the particular attention of the overseer. The ordinary gang, exclusive of mortar makers, was as follows:

For foundation Beton.

4 men bringing shingle and mixing.

2 men transporting beton, (each filling his own barrow) and mixing.

1 man at trench, levelling and ramming, to whom two others were occasionally added, in which case four men were kept constantly at the shovel and hoe, turning and mixing.

For Backing Beton.

2 men bringing shingle and mixing.

2 men wheeling beton and mixing.

2 men at the wall, one plastering the surface in contact with the beton, the other arranging the beton and ramming.

Each course of facing stones was backed up as fast as laid, the back of the beton being sustained by moveable boxings, each consisting of a couple of 2″ planks about 20 feet in length, fastened together, edge to edge, with battens, and kept in place by *plank* or *joist* braces in rear. These boxings could be safely removed in several hours after the beton was packed.

ANOTHER RAILROAD ROUTE BETWEEN NEW YORK & BOSTON.

We have received a circular signed by the principal citizens of Middletown Con., in which they call the attention of the inhabitants along the line to the project of a railroad through Middletown to Norwich, and thence to Providence and Boston. They say that "at the last session of the legislature of the State of Connecticut, a charter was granted for a railroad in continuation of the Hartford and New Haven railroad, to the line of New York State, in order to perfect a continuous road from Boston to New York city, at all seasons of the year.

"Another charter was also granted, to connect the city of Middletown with the Hartford and New Haven railroad; and it is now proposed to continue this road from Middletown, east to Providence and Boston via Norwich, by occupying a part of the Norwich and Worcester road to the most convenient point diverging therefrom to the Providence and Stonington road; or by such other route as upon examination shall prove most practicable. This project, if carried out, will place Providence, Norwich, Middletown and the intermediate towns, forever on the great mail route from Boston to New York city."

Of the advantage and convenience to the people on the proposed line we have not a doubt. The following comparative statement of distances between it and the Springfield route shows a saving of 19 miles.

New Haven to Boston by proposed route.			New Haven to Boston, via Springfield, &c.		
New Haven to Wallingford,	10	miles.	New Haven to Hartford,	37	miles.
Wallingford to Middletown,	13	"	Hartford to Springfield,	26	"
Middletown to Norwich,	32	"	Springfield to Worcester,	59	"
Norwich to Plainfield,	15	"	Worcester to Boston,	45	"
Plainfield to Stonington, R. I.,	24	"	Total,	167	"
Thence to Providence,	13	"		148	"
Providence to Boston,	41	"			
Total,	148	"	Difference in favor of proposed route,	19	"

Total extent of new road to be constructed on proposed route, 69 miles.

ON THE MENSURATION OF EXCAVATION AND EMBANKMENT UPON CANALS, ROADS, AND RAILROADS: BY ELWOOD MORRIS, CIVIL ENGINEER.

On directing the attention to public works, one is immediately struck with the vastness of the amount of money expended in excavation, embankment and masonry: forming on the roads and railroads, usually the chief, and on the canals nearly the only items of outlay. We have the authority of the Chev. de Gerstner, that the 3000 miles of railway this year in operation in the United States, cost sixty millions of dollars.* Of which, perhaps, forty millions were laid out in graduation and masonry alone.

When to this, we add the immense expenditures for similar objects upon the canals and roads of the Union, will it be too much to say that near one hundred millions of dollars have been disbursed in the earthworks, requisite to reduce the routes to proper levels, and the architectural constructions necessary to pass the streams.

This large amount of work having been done chiefly by contract, and paid for by the cubic yard, or perch, the vast importance of accuracy and uniformity in calculating the contents of excavation, embankment and masonry solids, must be palpable to all. Unfortunately, great diversity has existed, and still continues to exist, in the modes of mensuration adopted by engineers; they may, however, in a general way, be divided into two principal methods, and the modifications which flow from them; first, those which depend on *arithmetical* and second, those dependant on *geometrical*, average.

When we state that neither of these modes is exact, except in a limited number of cases, we merely mention what is well known to every engineer; but which is a reason not the less powerful, to induce us to seek more perfect methods.

The importance of this subject will, we trust, be a sufficient apology for laying before the readers of the Journal of the Franklin Institute a few observations, with the hope of drawing to it the attention of abler minds.†

We are aware, that it is urged by some, that the modes of measurement are immaterial, provided, the values of the unit of measure computed in a particular mode were known, and that mode generally adopted; and this argument would have great force if any single rule or method of mensuration was used in general practice. But while on some works the mode of computation uniformly errs in excess, on others it probably errs in deficiency, or, otherwise, according to circumstances; and this brings us back to the importance of a uniform and more exact mode.

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* See Journal Franklin Institute for September, 1839.

† A treatise on the mensuration of excavation and embankment, from the pen of a northern engineer, well able to manage such a subject, was lately announced as being in the press, it has not however (the writer believes) yet been published.

The work here referred to by Mr. Morris, is that of E. F. JOHNSON, Esq., C. E., which our readers will recollect, was published at our office in 1840. ED. R. R. J.

The surface of the ground is regarded by the engineer, as being composed of planes, variously disposed with relation to each other; so that any vertical section, will exhibit a rectilineal figure more or less regular. This supposition, though not strictly correct, is sufficiently accurate for practical purposes, and avoids any necessity of entering into the complex calculations pertaining to warped surfaces.

The usual method of measuring excavation and embankment, is by taking vertical sections, perpendicular to the centre line of the canal or road, and at short distances apart, in which the elevation or depression of numerous points in the ground, above or below the bottom of canal or grade of road, is ascertained by the spirit level and rod, while their distances out, right and left, are measured (generally) with a tape line.

These elevations or depressions are commonly called *plus* or *minus cuttings*, or simply *cuttings*, and the distances of the several points from the centre line are denominated shortly *distances out.* The *cuttings* then are ordinates or perpendiculars drawn from the plane of grade or bottom, to intersect the surface of the ground; and the *distances out*, are the horizontal distances of those perpendiculars from the centre line, (measured at right angles) or the abscissa of those ordinates, which, by deduction, give the distances apart of the separate cuttings.

The details of the operation of *taking the cuttings* require great nicety, but are so well known to practical engineers as to render unnecessary a description at length. We may, however, mention a general rule which must not be neglected if accurate results are desired; viz. *At every change of slope transversely, single cuttings and distances out, must be taken, and at every longitudinal change, sections of cuttings.*

Upon rough ground it is customary to make the lateral distances apart of the cuttings uniformly ten feet, which materially facilitates the subsequent calculations. We may here observe that the cuttings and distances out, are commonly taken in feet and tenths, and the regular stations of one hundred feet, are divided by cross sections (or sections of cuttings) into shorter lengths if the ground requires, as it almost always does.

Some engineers have suggested the division, and we believe some have had their rods and tapes divided, into yards and decimals; and some retaining the rod and tape as usual, have made their regular stations fifty-four feet, and have spaced their cross sections where they required to be nearer, so that their distances apart should be some aliquot part of 54 feet. These methods, though they somewhat expedite the office work where the quantities are ascertained by the process of arithmetical average, are not, however, generally adopted by the profession. A foot being usually the unit of lineal measure, a hundred feet a regular station, and the cubic yard the unit of the solidity of excavations and embankments.

The isometrical diagram, fig. 1, plate 1, represents a regular station of embankment on irregular ground, with an intermediate cross section at 50 feet or midway. Base or width of road surface $=$ 30 feet, slopes 2 to 1, *a*, *b*, *c*, *d*, e_1 *f* and *g*, are cuttings, *minus cuttings*, in this case. 1: 2: and 3: are the *sections of cuttings*, or cross sections. C, C, is the centre line.

Earth work on roads and canals is usually laid off in divisions called *sections* of half a mile or more in length, and when a sufficient number of transverse sections of the ground have been obtained, or technically when the "*cuttings are taken,*" the transverse profiles or cross sections are drawn upon paper, their areas calculated, and the solid contents of the excavations and embankments computed; generally by one of two rules, viz:

No. 1: *By arithmetical average.*—Multiply the sum of the end areas by their distance apart, and divide the product by 6 and by 9; the result will give, *approximately*, the number of cubic yards in the given length of excavation or embankment.

No. 2: *By geometrical average.*—Multiply the sum of the end areas, and the square root of their product, by the distance apart, and divide the product by 9 and by 9. The result will be, *nearly*, the number of cubic yards in the given length of excavation or embankment.

All the dimensions in both cases being in feet and decimals.

Of these rules, No. 1, gives a result always in excess, except when the excavation or embankment solid, happens to be a prism or cylinder, or when the sums of the right and left distances out, are the same for both the end areas used.

And, No. 2, though accurate when applied to prisms, cylinders, pyramids and cones, or their frustra, fails on application to the prismoid or wedge as well as to embankment or excavation solids, on irregular ground, where the difference is great between the areas of adjacent transverse sections.

Such is a brief sketch of the modes in common use for measuring excavation and embankment on roads and canals; of which we may observe, that the method, (No. 1,) and all others founded upon the same principles, necessarily lead to errors, often of magnitude, and particularly in deducing "deficient embankment," as is very well shown by Mr. Macneill, in the introduction to his excavation and embankment tables published in 1833. It is true, that engineers in this country would seldom fail to arrive at much closer results than Mr. Macneill has instanced; because, being well aware, that this very convenient rule (No. 1,) always gives results which are in excess in some ratio to the difference of any two areas averaged, they take care to place their cross sections so near together that this difference may be small, and consequently by closely pursuing this course are enabled to reach results proportionally more exact. Indeed, the writer has often known sections of cuttings on sidehill, to be taken but 20 feet apart longitudinally, and in some extraordinary cases among rocks even at a less distance.

The rule No. 2, though not liable to so many, nor such strong objections, is still obnoxious to some: and where greater, indeed almost precise, accuracy is attainable without much more labor, we cannot but think it highly desirable, and accordingly propose to develope a method much superior, as it appears to us. But before doing so, the writer distinctly disclaims any attempt at novelty, as to the principles employed; for they have been long known to those versed in mensuration, and have also been applied to the matter in hand by the eminent engineer before alluded to (J. Macneill, Esq., C. E., etc.,) in his publication in 1833. It is believed, however, that as a *general process* the mode about to be laid down has not yet been used on any work.

Upon the general supposition that any given length of excavation or embankment is a solid bounded laterally by plane surfaces, and terminated at both ends by transverse sections, or planes, perpendicular to the centre or guiding line of the excavation or embankment; the contents of that solid may be accurately computed by aid of the "prismoidal formula," used by Mr. Macneill, who gives a very good demonstration of it as applied directly to one of the solids under consideration. Mr. Macneill's tables, though carefully made out, and undoubtedly useful in a level country, are unfortunately not of very ready application to common cases, owing to the variable transverse figure of the ground not having been (and which indeed is

scarcely capable of being) taken into the account in the tabular arrangement employed by that distinguished practical writer.

The "Prismoidal Formula" referred to, is as follows:

Parallel sections each perpendicular to the guiding line of the excavation or embankment.

Let b = the area of the base, or of a cross section at one end of a given length of excavation or embankment.
" t = the area of the top, or other end section.
" m = the area of a section midway between the two, and deduced from them.
" h = the height of the solid, or perpendicular distance between the end sections.
" S = the solidity.

Then the general formula $= \overline{b+4m+t} \times \frac{1}{6}h = S$.

This is the rule for the capacity of a prismoid, demonstrated in almost every treatise on mensuration. And it is also *the general formula* for the mensuration of all solids, whose bases and tops, or edges, lie in parallel planes, and whose sides are bounded either by planes or right lines; and from it can be directly deduced the common rules for the solidity of prisms, etc., as will be shown hereafter.

* It applies to a prism or cylinder as a prismoid, (so to speak) of which the two end sections are equal: to a cone or pyramid as a similar solid, one of whose end sections is nothing; and for the same reason it is applicable to the wedge. As the full demonstration of this remarkable property would occupy much space, we prefer the inverse method of deducing from the general formula, the common rules for the solidity of prisms, pyramids, etc., the truth of which have been already proven by the writers on mensuration; this will be a proof of the general rule, perhaps quite as satisfactory to the reader, and will, at least, have the recommendation of brevity.

General formula $= \overline{b+4m+t} \times \frac{1}{6}h = S$.

1. *Prisms or Cylinders.*

Here $b = m$, or $4m = 4b$, and $t = b$, substituting these values, general formula becomes $\overline{b+4b+b} \times \frac{1}{6}h = S$, or $6b \times \frac{1}{6}h = S$, or finally $b \times h = S$, which is the common rule, usually expressed thus,

"Multiply the area of the base by the height of the prism, and the product will give the solid content."

By figures referring to the diagram, fig. 2, plate 1.

By General Formula.	By Common Rule.
$10 \times 8 = 80 = b$	$10 \times 8 = 80 = b$
$10 \times 8 \times 4 = 320 = 4m$	$48 = h$
$10 \times 8 = 80 = t$	$b \times h = 3840 = S$.
480	
$8 = \frac{1}{6}h$	
$3840 = S$.	

2. *Pyramids and Cones.*

Here $t = o$, $m = \frac{1}{4}b$, or $4m = b$, substituting these values the general formula becomes $\overline{b+b+o} \times \frac{1}{6}h = S$, or $2b \times \frac{1}{6}h = S$, or finally $b \times \frac{1}{3}h = S$, which is the common rule usually stated in words thus,

* This subject is noticed by (I believe) Sir George Head, in a work on England, speaking of a system of education.

"Multiply the area of the base by one third of the height, and the product will be the solid content."

By figures referring to the diagram, fig. 3, plate 1.

By General Formula.	By Common Rule.
$10 \times 8 = 80 = b$	$10 \times 8 = 80 = b$
$5 \times 4 \times 4 = 80 = 4m$	$16 = \frac{1}{3}h$
$0 \times 0 = 0 = t$	$\overline{1280} = S.$
$\overline{160}$	
$8 = \frac{1}{6}h$	
$\overline{1280} = S.$	

3. *The Wedge.*

Here let e = length of the edge, l = length of the back, and d = depth or thickness of the back.

Then in the general formula, $t = o$. $b = l \times d$, $m = \frac{l+e}{2} \times \frac{d}{2}$ or $4m = \overline{l+e} \times d$, substituting these values, general formula becomes $\overline{l \times d + \overline{l+e} \times d} \times \frac{1}{6}h = S$, or $\overline{l \times d + l \times d + e \times d} \times \frac{1}{6}h = S$, or finally $\overline{2l+e} \times d \times \frac{1}{6}h = S$, which is the common rule usually expressed thus,

"To the length of the edge, add twice the length of the back; multiply this sum by the breadth (or thickness) of the back, and then by one sixth of the height of the wedge; the product will be the solid content."

By figures see the diagram, fig. 4, plate 1.

By General Formula.	By Common Rule.
$10 \times 8 = 80 = b$	$10 \times 2 + 30 = 50 = 2l + e$
$20 \times 4 \times 4 = 320 = 4m$	$8 = d$
$0 \times 30 = 0 = t$	$\overline{400}$
$\overline{400}$	$8 = \frac{1}{6}h$
$8 = \frac{1}{6}h$	$\overline{3200} = S.$
$\overline{3200} = S.$	

To the frustra of either of the above solids, the general formula is equally applicable, to prove which we observe, that the frustrum of a prism is still a prism, and the frustrum of a wedge is a prismoid; it only remains then to show the application to

4. *The Frustrum of a Pyramid.*

Here, for the sake of simplifying the demonstration, suppose the frustrum to be of a pyramid having a square for its base. Let a = a side of the base of the frustrum, and c = a side of the top. Then in the general formula $b = a^2$ $t = c^2$ and $m = \frac{a+c}{2} \times \frac{a+c}{2}$ or $m = \frac{\overline{a+c}^2}{4}$ hence $4m = \overline{a+c}^2 = a^2 + 2ac + c^2$. Substituting these values the general formula becomes $\overline{a^2 + a^2 + 2ac + c^2 + c^2} \times \frac{1}{6}h = S$, or $\overline{2a^2 + 2ac + 2c^2} \times \frac{1}{6}h = S$, or $\overline{a^2 + ac + c^2} \times \frac{1}{3}h = S$.

But $ac = \sqrt{a^2 \times c^2}$ substituting which the formula becomes $\overline{a^2 + \sqrt{a^2 \times c^2} + c^2} \times \frac{1}{3}h = S$, which is the common rule usually expressed thus,

"The sum of the areas of the ends and the square root of their product,

multiplied by one third of the height (or perpendicular distance between the ends) gives the solidity of the frustrum."

What is true of frustra of pyramids is also true of those of cones, though owing to the properties of the circle, the rule for the solidity of conic frustra is generally differently stated: it will be observed that the common rule above deduced for pyramidal frustra is identical with rule No. 2, sometimes used to find the contents of excavations and embankments.

By figures see the diagram, fig. 5, plate 1.

By General Formula.	By Common Rule.
$20 \times 20 = 400 = b$	$20 \times 20 = 400 = a^2$
$16 \times 16 \times 4 = 1024 = 4m$	$\sqrt{400 \times 144} = 240 = \sqrt{a^2 \times c^2}$
$12 \times 12 = 144 = t$	$12 \times 12 = 144 = c^2$
1568	784
$8 = \frac{1}{6}h$	$16 = \frac{1}{3}h$
$12544 = S.$	$12544 = S.$

Now there is no excavation or embankment solid such as we have supposed, that cannot be divided into prisms, prismoids, pyramids, or wedges, or some combination of them, having a common length or height, equal to the distance between the end areas or cross sections. And the height or length being common to all, it will be evident on reflection, that if a given portion of excavation or embankment be composed of any number of the solids named, the area of one end section will equal the sum of the areas of the bases or tops of those solids, the other end area the sum of their tops or bases, and the area of the mid-section will equal the sum of the areas of their middle sections; and, hence, if (as has been proved) the capacities of the separate solids are reducible to one general rule, the solidity of a whole body composed of such solids, and having the height as one common dimension, may therefore be computed by the same rule.

The general process, then, the adoption of which we suggest as a valuable succedaneum to those in common use, will be to compute by the general formula from the sections usually taken in the field, in the following manner: draw the sections in a book, leaving between each two space enough for the middle section, which will be subsequently deduced from those drawn; on each left hand page should be placed either three sections, (including the mid-section) or some multiple of three, depending on the character of the ground, and the size of the leaf; the right hand page being left open to record the calculation upon. The scale we would recommend to be twenty feet to the inch.

To prevent misapprehension, we will here observe, that in speaking of excavation or embankment, the centre line is always supposed to be a tangent, that being the universal presumption, in practical calculations; altho' upon curves, owing to the convergence of the cross sections, (they being taken on the radii,) this hypothesis is not exact, and consequently occasions some error, not often, however, of much importance, though cases will sometimes arise (where the primary angle of deflection is unusually large) that ought to receive correction for curvature.

Though not absolutely indispensable, it will be found convenient in using the prismoidal method of calculation, as well as conducive both to expedition and accuracy, to observe the following rules in "*taking the cuttings*," as far as the character of the surface may admit, viz:

1. On sidehill, at each section of cuttings where the work runs partly in

filling, and partly in cutting, ascertain the point where grade or bottom strikes ground surface.

2. On every tarnsverse section take a cutting at both edges of the road; or, at the distance out right and left of the half the base.

3. Always take a cross section, whenever either edge of the road or base passes from excavation to embankment or vice versa.

4. On sidehill, if the ground admits, take the cuttings (not otherwise provided for) uniformly at ten feet apart.

5. Wherever the ground admits, so place the cross section as to be at some decimal division of 100 feet apart, as 10, 20, etc.

Excavation and embankment solids naturally divide themselves into three classes or cases, with modifications, and under one or another of these cases or their modifications, will fall nearly every kind of ground; though on a very intricate surface, such as a rocky hillside, cases may arise, requiring additive or deductive solids, but the engineer will find little difficulty in managing such, without violating, or interfering with, the general process.

Case 1. *Prisms.*

Embankment or excavation, either on level ground, or on ground inclined transversely, and level longitudinally, at the same distance out.

Modification 1: all excavation, or all embankment. *Modification* 2: both filling and cutting.

Case 2. *Prisms, Prismoids and Pyramids.*

Embankment or excavation, on ground inclined longitudinally in one plane, and level transversely.

Modification 1: all excavation, or all embankment. *Modification* 2: passage from excavation to embankment, or the reverse.

The above two cases do not often exist in practice, that following being of the most general occurrence.

Case 3. *Prisms, Prismoids, Pyramids and Wedges, or a combination of them.*

Excavation or embankment on ground inclined *both* longitudinally and transversely.

Modification 1: all excavation, or all embankment. *Modification* 2: cutting and filling both. *Modification* 3: passage from cutting and filling to either cutting or filling. *Modification* 4: complete passage from excavation to embankment on sidelong ground.

The general formula admits of a modification, more convenient for use in computing excavation and embankment. It is as follows:

$\frac{b+4m+t}{6} \times h = S$, in lieu of $\overline{b+4m+t} \times \frac{1}{6}h = S$; this modification we shall employ; and now proceed to give examples in figures of each case, but it may be as well previously, to make some remarks relative to deducing the middle section between any two which have been taken in the field and sketched in the section book.

To average for the cuttings of the middle section, commence either at centre or at grade, if there be a grade point upon the cross section, and, having regard to the inclination of the ground, proceed each way, averaging the cuttings as they occur, for a corresponding cutting of the middle section, and their distances out, or rather their distances apart, for a corresponding distance apart; and if there be more cuttings in one section than in the other, the surplus cuttings (of the same kind) on each side, all average with the *outer* cutting on that side, and their distances apart divided by

two (or averaged with 0,) give the corresponding distances of the cuttings which answer to them upon the mid-section. But the averages may be made in any other way demanded by the transverse slopes of the surface, provided all the cuttings are used, and that lines drawn to join any two cuttings averaged, do neither meet between the end sections nor cross. In the mid-section will always appear the same number of cuttings as are contained in that end section which has the most; and its correctness admits of verification thus,

1. ½ sum of distances between the extreme cuttings of the end sections equals the distance between the extreme cuttings of the mid-section. This proves it horizontally: to verify it vertically,

2. Where the number of cuttings of both kinds is the same in each end section, ½ sum of all the cuttings of the end sections, equals the sum of all the cuttings of the middle section.

3. Where the number of cuttings in the end sections is different, to prove the cuttings of excavation, ½ sum of the cuttings of the end sections, equals the sum of the cuttings of the mid-section; *minus*, least outer cutting left of centre multiplied by ½ the difference in the number of cuttings in the end sections on the left; *plus*, least outer cutting right of centre multiplied by the difference in the number of cuttings on the right.

Though this last rule is long in words, it is short in practice, and of course only refers to the excavation or plus cuttings in proving excavation, while the same process applied to the minus cuttings will verify the embankment of the middle section.

The exemplifications which will be given apply to the graduation of a road, or railroad, but the principles apply equally to a canal, as the tow path and berm banks above bottom are constant quantities.

In all the following examples the slopes are considered to be the same on both sides of the centre, which is supposed to divide equally the surface of grade, or the base as it will be called. The sections numbered 1: and 3: will uniformly be presumed to be those taken in the field, while No. 2: will represent the middle section deduced from the end sections, 1: and 3: the distance between which, will, for convenience, be assumed at 30 feet in every case. Excavations, as to figure, are merely embankments inverted, and hence, as a matter of course, the same principles apply to both.

In all the examples, the results obtained by rules No. 1 and 2, will also be set down for the sake of exhibiting how great in some cases the differences are: the base will be assumed at 30 feet, the slopes at 2 to 1, and C, C, will represent the centre line of the road.

Example of Case 1: Modification 1: fig. 6, plate I.

$b = 30.$

	Multipliers.	Areas.	Cubic yds.
1.	$\frac{30+54}{2} \times 6$	= 252	
2.	$\frac{30+54}{2} \times 6 \times 4$	= 1008	
3.	$\frac{30+54}{2} \times 6$	= 252	
		6)1512	
	30 ×	252	= 280
	By rule No. 1		= 280
	By rule No. 2		= 280

Fig. 1.

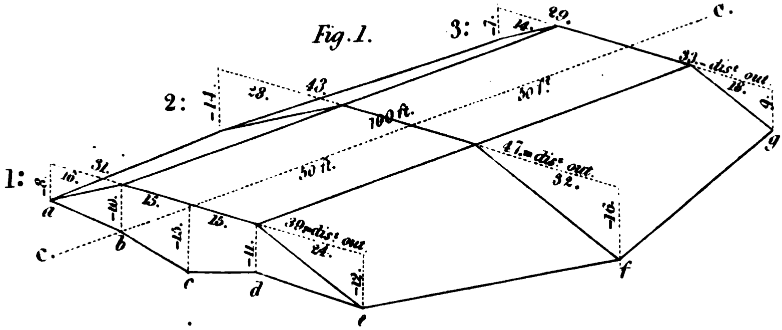

Fig. 2.

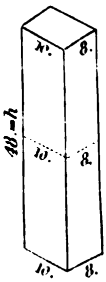

Fig. 3.

Fig. 6.

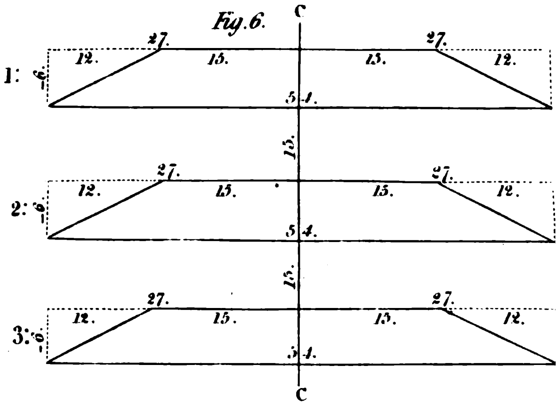

Fig. 4.

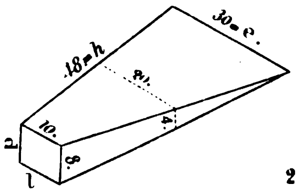

Fig. 7.

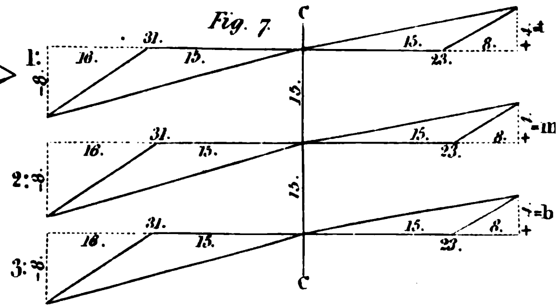

Fig. 5.

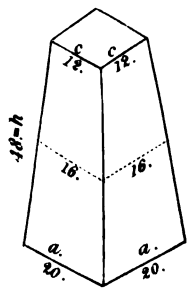

Fig. 8.

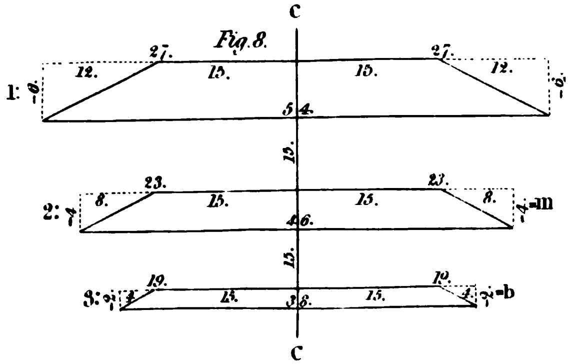

Fig. 9.

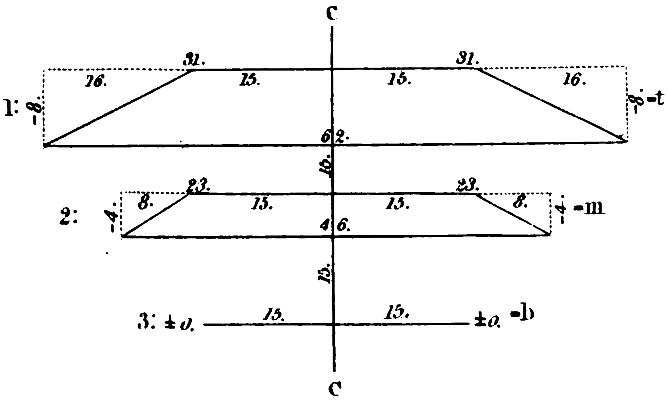
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Fig. 10.

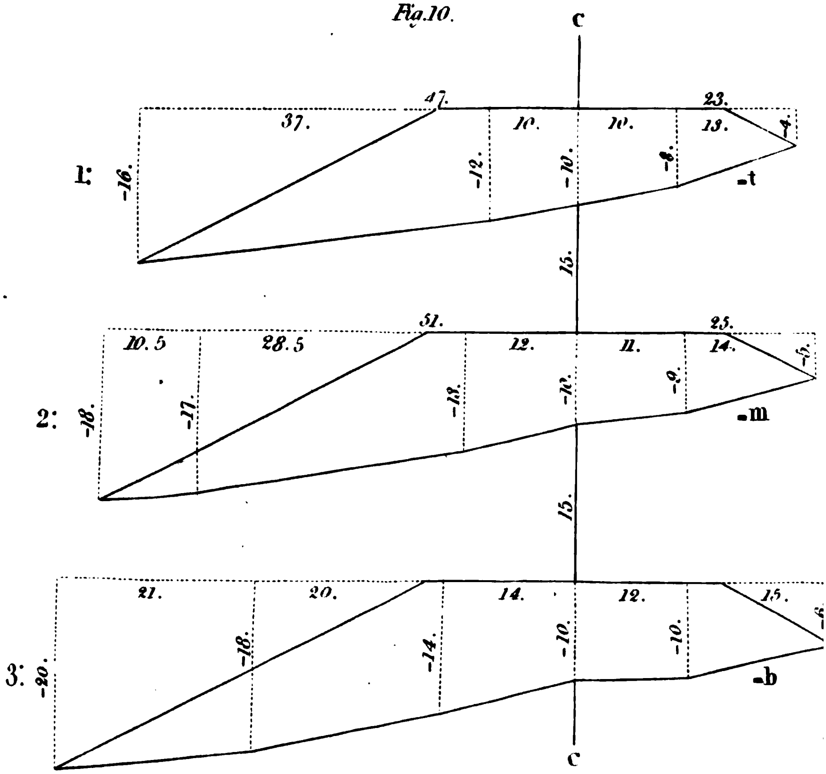
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Fig. 11.

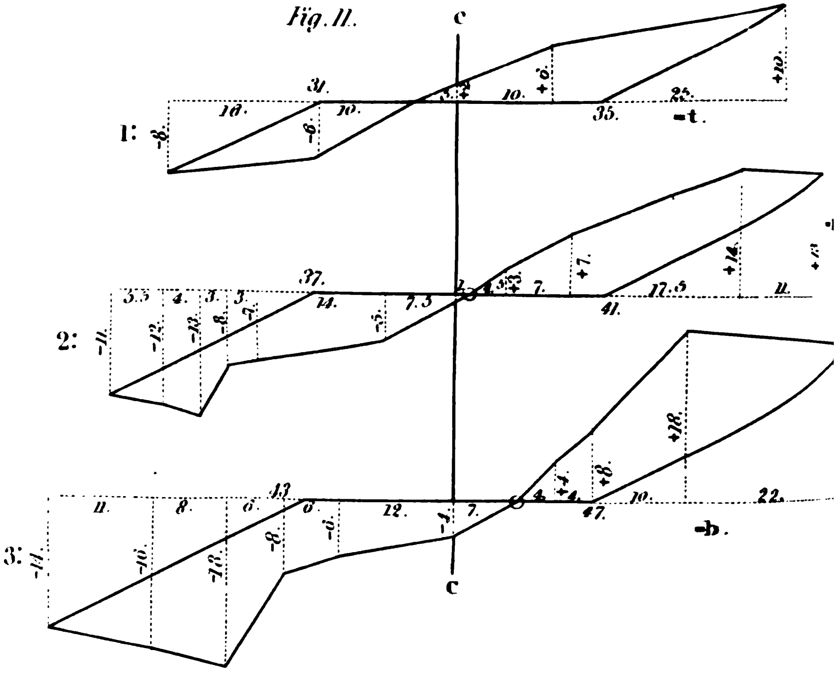


Fig. 13.

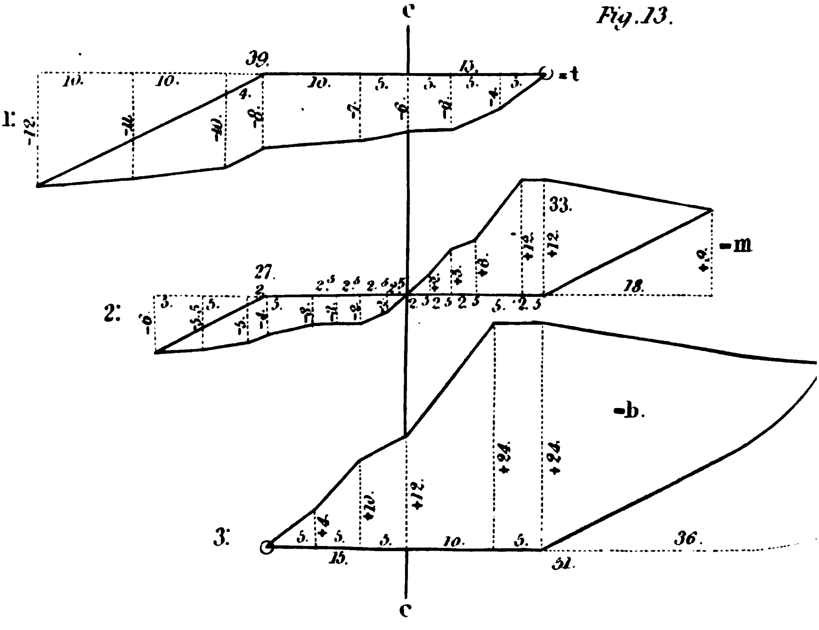
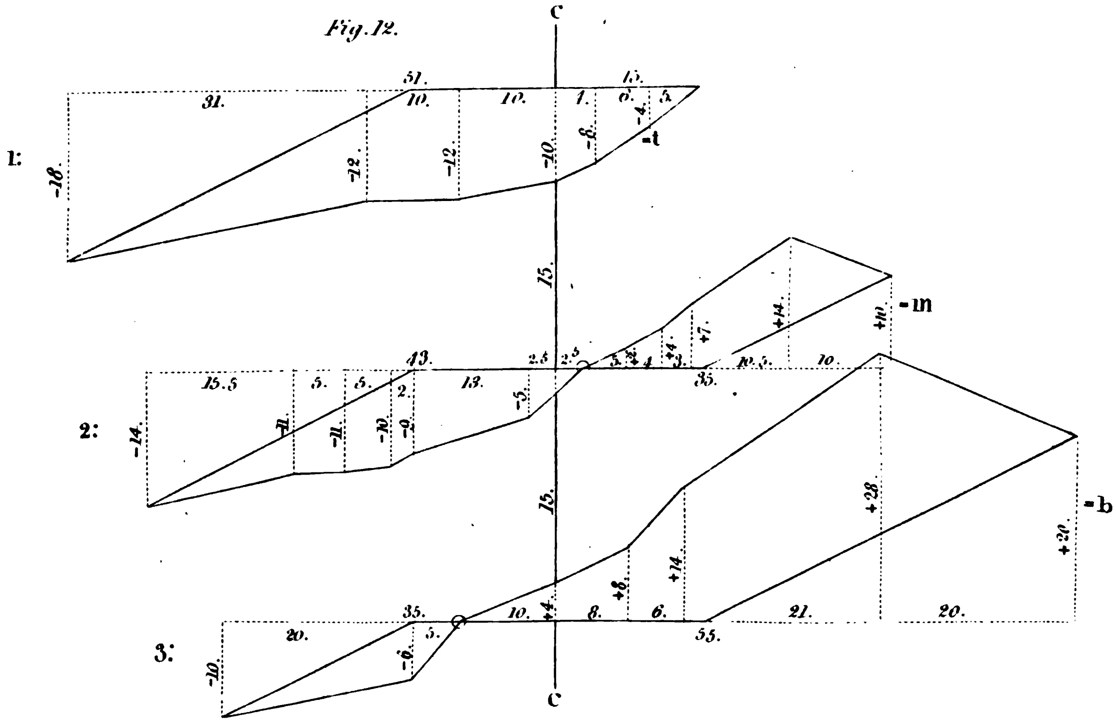


Fig. 12.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6.
21.
20.
55.
-10.
-6.
+4.
+8.
+14.
+28.
+20.

Example of Case 1: Modification 2: fig. 7, plate I.

Embankment.

	Multipliers.	Areas.	Cub. yds.
1.	$15 \times 4 =$	60	
2.	$15 \times 4 \times 4 =$	240	
3.	$15 \times 4 =$	60	
		6)360	
	$30 \times$	$60 =$	$66\frac{2}{3}$
	By rule No. 1	$=$	$66\frac{2}{3}$
	By rule No. 2	$=$	$66\frac{2}{3}$

Excavation.

Multipliers.	Areas.	Cub. yds.
$15 \times 2 =$	30	
$15 \times 2 \times 4 =$	120	
$15 \times 2 =$	30	
	6)180	
$30 \times$	$30 =$	$33\frac{1}{3}$
By rule No. 1	$=$	$33\frac{1}{3}$
By rule No. 2	$=$	$33\frac{2}{3}$

Example of Case 2: Modification 1: fig. 8, plate I.

	Multipliers.	Areas.	Cub. yds.
1.	$\frac{30+54}{2} \times 6 =$	252	
2.	$\frac{30+46}{2} \times 4 \times 4 =$	608	
3.	$\frac{30+38}{2} \times 2 =$	68	
		6)928	
	$30 \times 154\frac{2}{3} =$		171·8
	By rule No. 1	$=$	177·8
	By rule No. 2	$=$	167·0

Example of Case 2: Modification 2: fig. 9, plate II.

Multipliers.	Areas.	Cub. yds.
$\frac{30+62}{2} \times 8 =$	368	
$\frac{30+46}{2} \times 4 \times 4 =$	608	
$0 \times 15 =$	0	
	6)976	
$30 \times 162\frac{2}{3} =$		180·7
By rule No. 1	$=$	204·4
By rule No. 2	$=$	136·3

Example of Case 3: Modification 1: fig. 10, plate II.

	Multipliers.		Areas.	Cubic yds.
1.	Add	$37 \times 14 = 518$		
		$11 \times 10 = 110$		
		$18 \times 5 = 90$		
		$13 \times 6 = 78$		
		796		
	Deduct	$\overline{16}^2 + \overline{4}^2 = 272$		
		524	= 524	
2.	Add	$17·5 \times 10·5 = 183·75$		
		$15· \times 28·5 = 427·50$		
		$23· \times 6· = 138·$		
		$19· \times 5·5 = 104·50$		
		$7· \times 14· = 98·$		
		951·75		
	Deduct	$\overline{18}^2 + \overline{5}^2 = 349·$		
	Multiplied by 4,	602·75	= 2411	
3.	Add	$19 \times 21 = 399·$		
		$16 \times 20 = 320·$		
		$12 \times 14 = 168·$		
		$10 \times 12 = 120·$		
		$8 \times 15 = 120·$		
		1127·		
	Deduct	$\overline{20}^2 + \overline{6}^2 = 436·$		
		691	= 691	
			6)3626	
		$30 \times$	$604\frac{1}{3}$	= 671·5
		By rule No. 1		= 675·0
		By rule No. 2		= 672·9

Example of Case 3: Modification 2: fig. 11, plate III.

	Excavation. — Multipliers.	Areas.
	5 × 1 = 5	
1.	4 × 10 = 40	
	8 × 25 = 200	
	245	
	Deduct $\overline{10}^2$ = 100	
	145 =	145
	4·5 × 1·5 = 6·75	
	5· × 7· = 35·	
2.	10·5 × 17·5 = 183·75	
	13·5 × 11· = 148·5	
	374·	
	Deduct $\overline{13}^2$ = 169·	
	4 × 205 =	820
	4 × 2 = 8	
	4 × 6 = 24	
3.	13 × 10 = 130	
	17 × 22 = 374	
	536	
	Deduct $\overline{16}^2$ = 256	
	280 =	280
		6)1245
	Mean area =	207·5

Embankment. — Multipliers.	Areas.
16 × 7 = 112	
6 × 5 = 30	
142	
Deduct $\overline{8}^2$ = 64	
78 =	78
11·5 × 5·5 = 63·25	
12·5 × 4· = 50·	
10·5 × 3· = 31·5	
7·5 × 3· = 22·5	
14· × 6· = 84·	
8·5 × 2·5 = 21·25	
272·5	
Deduct $\overline{11}^2$ = 121·	
4 × 151·5 =	606
15 × 11 = 165	
17 × 8 = 136	
13 × 6 = 78	
7 × 6 = 42	
12 × 5 = 60	
7 × 2 = 14	
495	
Deduct $\overline{14}^2$ = 196	
299 =	299
	6)983
Mean area =	163⅚

Excavation.		Cub. yds.	Embankment.		Cub. yds.
Mean area,	207·5 × 30	= 230·6	Mean area,	163⅚ × 30	= 182
By rule No. 1,		= 236·1	By rule No. 1,		= 200·4
By rule No. 2,		= 232·0	By rule No. 2,		= 196·6

Example of Case 3: Modification 3: fig. 12, plate IV.

	Embankment. — Multipliers.	Areas.
	15 × 31 = 465	
	12 × 10 = 120	
1.	11 × 10 = 110	
	9 × 4 = 36	
	6 × 6 = 36	
	2 × 5 = 10	
	777	
	Deduct $\overline{18}^2$ = 324	
	453 =	453
	5·5 × 12·5 = 193·75	
	11· × 5· = 55·	
2.	10·5 × 5· = 52·5	
	9·5 × 2· = 19·	
	7· × 13· = 91·	
	5· × 2·5 = 12·5	
	423·75	
	Deduct $\overline{14}^2$ = 196·	
	4 × 227·75 =	911
	Carried forward	1364

Excavation. — Multipliers.	Areas.
Excavation =	0
5· × 1· = 5·	
3· × 4· = 12·	
5·5 × 3· = 16·5	
10·5 × 10·5 = 110·25	
12· × 10· = 120·	
263·75	
Deduct $\overline{10}^2$ = 100·	
4 × 163·75 =	655
Carried forward	655

	Areas.		Areas.
Brought forward	1364	Brought forward	655
3. $8\times20=160$		$5\times4=20$	
$3\times5=15$		$6\times8=48$	
175		$11\times6=66$	
Deduct $\overline{10}^2=100$		$21\times21=441$	
75 =	75	$24\times20=480$	
		1055	
		Deduct $\overline{20}^2=400$	
		655 =	655
	6)1439		6)1310
Mean area =	$239\frac{5}{6}$	Mean area =	$218\frac{1}{3}$

Embankment.	Cub. yds.	Excavation.	Cub. yds.
Mean area, $239\frac{5}{6}\times30$	$=266{\cdot}5$	Mean area, $218\frac{1}{3}\times30$	$=242{\cdot}6$
By rule No. 1,	$=293{\cdot}3$	By rule No. 1,	$=364{\cdot}$
By rule No. 2,	$=263{\cdot}8$	By rule No. 2,	$=242{\cdot}6$

Example of Case 3: Modification 4: fig. 13, plate III

Excavation.—Multipliers.	Areas.	Embankment.—Multipliers.	Areas.
		$11{\cdot}5\times10=115{\cdot}$	
		$10{\cdot}5\times10=105{\cdot}$	
		$9{\cdot}\times4=36{\cdot}$	
1. Excavation =	0	$7{\cdot}5\times10=75{\cdot}$	
		$6{\cdot}5\times5=32{\cdot}5$	
		$6{\cdot}\times5=30{\cdot}$	
		$5{\cdot}\times5=25{\cdot}$	
		$5{\cdot}\times2=10{\cdot}$	
		$428{\cdot}5$	
		Deduct $\overline{12}^2=144{\cdot}$	
$2{\cdot}5\times1{\cdot}=2{\cdot}5$		$284{\cdot}5$ =	$284{\cdot}5$
$3{\cdot}5\times2{\cdot}5=8{\cdot}75$		$11{\cdot}5\times2{\cdot}5=28{\cdot}75$	
2. $5{\cdot}5\times2{\cdot}5=13{\cdot}75$		$10{\cdot}5\times2{\cdot}5=26{\cdot}25$	
$9{\cdot}\times5{\cdot}=45{\cdot}$		$9{\cdot}\times1{\cdot}=9{\cdot}$	
$12{\cdot}\times2{\cdot}5=30{\cdot}$		$7{\cdot}5\times2{\cdot}5=18{\cdot}75$	
$10{\cdot}5\times18{\cdot}=189{\cdot}$		$6{\cdot}5\times1{\cdot}25=8{\cdot}125$	
$289{\cdot}$		$3{\cdot}\times2{\cdot}5=7{\cdot}50$	
Deduct $\overline{9}^2=81{\cdot}$		$2{\cdot}5\times2{\cdot}5=6{\cdot}25$	
4×208 =	832	$1{\cdot}\times2{\cdot}5=2{\cdot}50$	
		$107{\cdot}125$	
		Deduct $\overline{6}^2=36{\cdot}$	
$3\times2=10$		$4\times71{\cdot}125$ =	$284{\cdot}5$
$7\times5=35$			
3. $11\times5=55$			
$18\times10=180$			
$24\times5=120$		Embankment =	0
$21\times36=756$			
1156			
Deduct $\overline{18}^2=324$			
832 =	832		
	6)1664		6)569
Mean area =	$277\frac{1}{3}$	Mean area =	$94{\cdot}83$

Fig. 11.

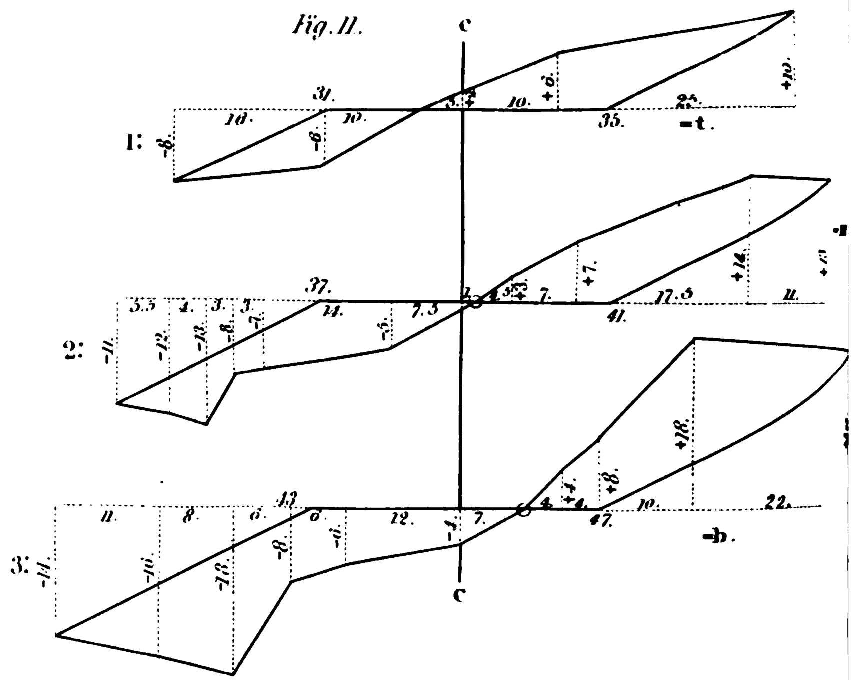


Fig. 13.

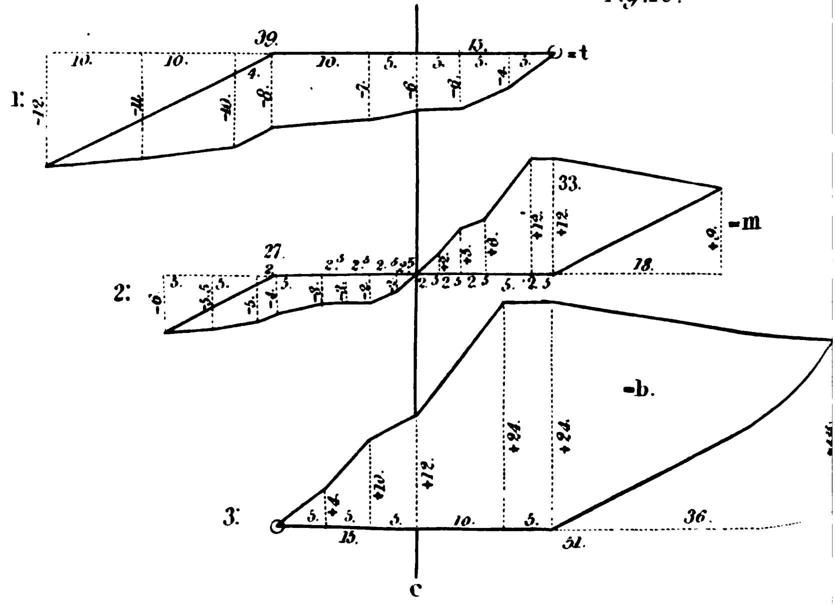
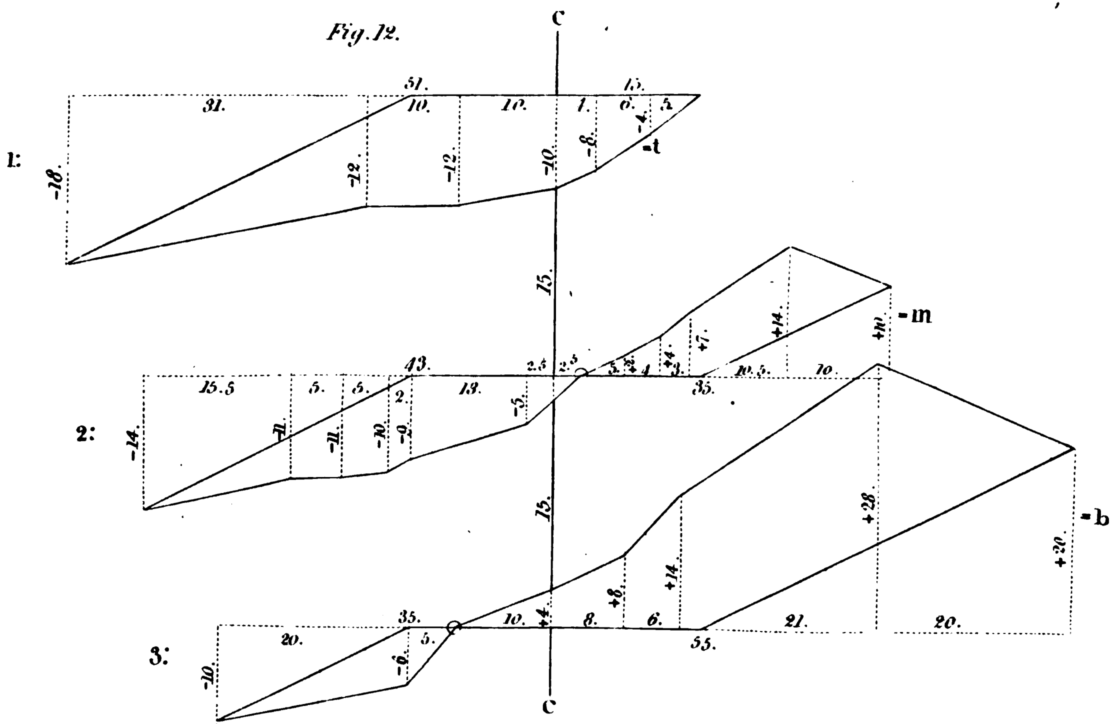


Fig. 12.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8.
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+8.
+14.
+28.
+20.
-6.
-10.

Embankment.

Multipliers.	Areas.	Cub. yds.
1. $15 \times 4 =$	60	
2. $15 \times 4 \times 4 =$	240	
3. $15 \times 4 =$	60	
	6)360	
$30 \times 60 =$		66⅔
By rule No. 1 =		66⅔
By rule No. 2 =		66⅔

Excavation.

Multipliers.	Areas.	Cub. yds.
$15 \times 2 =$	30	
$15 \times 2 \times 4 =$	120	
$15 \times 2 =$	30	
	6)180	
$30 \times 30 =$		33⅓
By rule No. 1 =		33⅓
By rule No. 2 =		33⅔

Example of Case 2: Modification 1: fig. 8, plate I.

Multipliers.	Areas.	Cub. yds.
1. $\frac{30+54}{2} \times 6 =$	252	
2. $\frac{30+46}{2} \times 4 \times 4 =$	608	
3. $\frac{30+38}{2} \times 2 =$	68	
	6)928	
$30 \times 154\frac{2}{3} =$		171·8
By rule No. 1 =		177·8
By rule No. 2 =		167·0

Example of Case 2: Modification 2: fig. 9, plate II.

Multipliers.	Areas.	Cub. yds.
$\frac{30+62}{2} \times 8 =$	368	
$\frac{30+46}{2} \times 4 \times 4 =$	608	
$0 \times 15 =$	0	
	6)976	
$30 \times 162\frac{2}{3} =$		180·7
By rule No. 1 =		204·4
By rule No. 2 =		136·3

Example of Case 3: Modification 1: fig. 10, plate II.

	Multipliers.	Areas.	Cubic yds.
	Add $37 \times 14 = 518$		
	$11 \times 10 = 110$		
1.	$18 \times 5 = 90$		
	$13 \times 6 = 78$		
	796		
	Deduct $\overline{16}^2 + \overline{4}^2 = 272$		
	524 =	524	
	Add $17·5 \times 10·5 = 183·75$		
	$15 \times 28·5 = 427·50$		
2.	$23 \times 6 = 138$		
	$19 \times 5·5 = 104·50$		
	$7 \times 14 = 98$		
	951·75		
	Deduct $\overline{18}^2 + \overline{5}^2 = 349$		
	Multiplied by 4, 602·75 =	2411	
	Add $19 \times 21 = 399$		
	$16 \times 20 = 320$		
3.	$12 \times 14 = 168$		
	$10 \times 12 = 120$		
	$8 \times 15 = 120$		
	1127		
	Deduct $\overline{20}^2 + \overline{6}^2 = 436$		
	691 =	691	
		6)3626	
	$30 \times 604\frac{1}{3} =$		671·5
	By rule No. 1 =		675·0
	By rule No. 2 =		672·9

would cost above £100,000 more than a canal on the south side of the St. Lawrence. The only engineer giving evidence against the board—Mr. Casey—said that, the lockage being the same on both sides and the incidental works not materially different and not very important on either side, the difference must be sought for in the earthwork. But the total cost of this by his estimate little exceeded £100,000 and at the prices of the board of works actually fell short of that sum. On seeing the estimates of the board he pointed out how they made out their case. We give one of his objections and an extract from Mr. Killaly's answer or defence, which, though not *exactly* a refutation of Mr. Casey's charge, is quite as much so as any other part of his paper.

"In looking over the estimates just submitted by the board of works, in order to answer a comprehensive question put to me some days before these documents were received, I perceive that the line on the north side, on which the board base their estimates, by which they are enabled to show a difference of £100,000 against that side, and by which a reluctant assent to the location of the canal on the south side has been wrung from the right honorable the secretary for the Colonies, is far, very far, inferior to *another* line connecting the same points, and *well known* to the board of works.

"By the 'inland route,' surveyed by directions of the commissioners, in 1833, for a canal 100 feet bottom, by 10 deep, one-sixth larger than the present canal, there are—

Excavation, - - - - -	cubic yards,	2788913
Embankment, - - - - -	"	310139
		3099052
Less one-sixth, - - - - -	"	516508
Total quantity by route of 1833, - - - -		2582544
By the route of the board of works, there are—		
Excavation, - - - - -	cubic yards,	3076000
Embankment, - - - - - -	"	289066
Total quantity by route of 1842, - - - -		3365066
" " " 1833, - - -		2582544
Difference in favor of route of 1833, -	cubic yards,	782522

N. B. See "note" to document 22.)

This, at one shilling per yard, would amount to nearly £40,000; but I pass this by at present.

"The entire investigation rests, and *necessarily* so, on the assumption, that the board have, in their comparison, brought forward the *best* line on *each* side; for there is no more justice in charging one line with difficulties, which it is known can be avoided, than in giving another line credit for facilities of which it is known it cannot avail itself. You will please observe that I refer exclusively to surveys made by government, in 1833 and 1842, the former of which are confirmed by my examinations of this year. The difference is sufficiently remarkable, both as to amount and direction, and I beg leave respectfully, but earnestly, to call your immediate attention to it."

Mr. Killaly says:

"Before looking at those voluminous documents, I had expected to find in them, at least, some testimony bearing upon the question at issue, worthy of my most serious attention; but a very cursory examination of it has been sufficient to convince me that the evidence itself is of a character to

preclude me or any other professional engineer, from attempting to analyse it, with a view to useful results. That portion of it, adduced in support of Mr. Simpson's charges, consists, for the most part, of matter which I may term a sort of ignorant gossip, almost wholly irrelevant to the subject. It is not indeed, wanting, in bold assertions of opinion; but those are made in language which is alone sufficient to prove to a man of experience that the witnesses by whom they have been made are profoundly ignorant of the very nature of the question, with respect to which they speak so confidently. The evidence is curiously characterized by vagueness, self-contradiction, confusion of ideas, gross exaggeration and positive misstatements.

There is but one point in which the witnesses are constant and consistent with themselves, and with each other—they all display, in a manner that must be obvious to any observer, a keen anxiety to establish Mr. Simpson's charges by means of reckless assertion. I think I may safely add, judging from internal evidence alone, that the testimony of the witnesses has been concocted among themselves, or that their minds have been under the guidance—not to say direction—of some one or more persons, whose business it has been to get up a case in support of Mr. Simpson's accusation against me. These witnesses would have seem to have been, as it were, well drilled for the occasion. From this description I do not except either the written or verbal testimony of Mr. Casey, the engineer, employed by Messrs. Simpson and Harwood, and brought forward by Mr. Simpson as a witness against me. This gentleman himself states, (I use his own words,) "the object of my examinations and report was not to furnish an estimate "of the probable cost of a canal on the north side, but merely to show that "the Hon. H. H. Killaly was wrong, in leading the public to believe that "a canal on the north side would cost £100,000 more than the south side;" and accordingly up to this very day, he had not made any estimate in full of the cost of constructing a canal on the north side: on the south side he states he has not been for seven years; and, in answer to a question, he says that when he came before the committee he was not aware of so important a point as the scale upon which the present canal is being constructed. These two statements are characteristic, in all respects, of the whole of his testimony, namely—the absence of any valuable or even available information, with respect to the particular subject which he pretends to examine. He might well say that his only object was to criticise a report of mine; for the greater part of his entire testimony consists of a sort of literary strictures on my report to the governor-general, of the 1st of August last, and is far more fit to form articles in a newspaper opposed to the government, than to be submitted to a committee of the legislature, with a view of guiding their judgment upon a scientific point. I am sure that, in my long professional career, I never met with anything, purporting to be the production of an engineer, which so clearly evinces a determination, *fas aut nefas*, to make out and bolster up a case for the employers, and so utterly undeserving of serious notice."

Mr. Simpson's main charge is that "vessels which the canal would be capable of bearing, will be incapable of getting in and out." (Ev. p. 59.) Mr. Killaly says (p. 60,) there are "three entrances of from [illegible] to [illegible] feet in width each and with a depth of water averaging from 12 to 20 feet." Now the pilots and numerous other persons in the neighborhood and two members of parliament, Messrs. Chesley and McLean, testified that in place of *channels* there were *shoals* with 2½ to 8½ feet in the deepest places! Mr.

Casey says "*no trace of a single such channel can be found.*" This objection is answered as follows:

"The other witnesses brought forward by Mr. Simpson, although they do not pretend to science, like Mr. Casey, are disqualified, by their utter ignorance of the subject, from offering any opinion to which I can pay respect. They consist of pilots, wharfingers, farmers, a stage-coach proprietor, a store-keeper, a doctor, a timber merchant, residing at Bytown and the agent of an insurance company; the latter being Mr. Simpson's step-son; and the whole of them, not excepting the merchant, at Bytown, are deeply interested persons."

We fully agree that Mr. C.'s scientific pretensions do not enable him to turn 3½ into 12 feet of water, though we still consider pilots, wharfingers and even members of parliament capable of sounding water 4 to 8 feet deep. Yet after all this, Mr. Killaly says there are "two channels with *not less* than 8½ feet water," while Mr. Chesley says (p. 12) "I found in not less than 40 places a depth not exceeding 3½ feet." This is one of those misstatements—we use exceedingly mild terms—which admit of but one explanation.

Mr. Killaly's only argument is, that those daring to differ from him may have some direct or indirect interest in the question at issue; and, having shown or asserted this, he considers their evidence *proved* unworthy of credence. The extent to which he believes in this ennobling principle is boundless and openly avowed; it would be merely ridiculous and contemptible but for the vast power vested in his hands which he has exercised in constructing works of the most absurd dimensions. The difference in his defence and that of Mr. Brunel or of Mr. Samuda is distressing, and powerfully illustrates our remarks in a late number on the importance of *character* to the engineer who aims at anything higher than his salary. How different would have been the state of the public works and of the finances of the Province, had the services of a professional man been obtained with the skill and charecter of an engineer and a gentleman! Even a flying visit from Mr. Brunel, Mr. Rennie, Mr. Vignolles, Mr. Stephenson or any other experienced British engineer might have saved Canada from spending immense sums on works which are not merely worse than useless themselves, but which act so powerfully in preventing the undertaking of works really needed by the country, and which would again by their success lead to the rapid extension of similar communications wherever the wants of the community were such as to justify the necessary outlay. A case in point has just occurred. Suppose that, instead of building a canal to rival the St. Lawrence—see the fable of the frog and the ox—a railway had been carried to the lines about 60 miles at half the cost of 12 miles of ship canal along a navigable river. Then the Province would have saved $800,000 direct, a considerable annual sum in repairs, would have possessed a work at least supporting itself from the beginning and which would soon have paid 4 per cent. on its small cost. Then we should not have seen the late important railroad convention at Boston take place *without an allusion to a*

communication with Montreal via the Connecticut and Passumpsic rivers. The object *then* would have been to carry the line as far north as possible; *now* they propose striking the south-east corner of Vermont. So that by utterly neglecting the cheap railway for the extravagant ship canal, the immediate benefits of the former are all lost to the present generation and its actual completion either delayed to a distant period, or it may be, altogether prevented. Such is the inevitable result of placing the public works—the most important of all interests in a new country—in the hands of political adventurers as ignorant of, as they are indifferent to, the interests of the confiding people on whom they batten.

We also find that some months after the work had been commenced the board was ignorant of "the nature of the bottom" of the shoals to be excavated, (p. 23) and, to cap the climax, that the board had *never met!* (p. 12). There was therefore nothing to interfere with the little arrangements of Messrs. Killaly and *Wakefield* whether of an engineering or financial nature. We are informed that the latter is generally considered to be the author of the paper from which we have made extracts, and it is every way worthy of "*his* long professional career." Of the "career" in which the former has displayed *his* "great scientific acquirements," (p. 40) we shall one of these days be able to speak with equal confidence.

For the American Railroad Journal and Mechanics' Magazine.

READING RAILROAD FOR 1845.

The advantages under which this railway will operate in 1845, and which it has not in 1844, although it will have delivered in this last year 400,000 tons besides the travel and merchandize, may be enumerated as follows:

1st. Full connection with *all* the mining points in the Schuylkill region.

2d. Motive power improved by Baldwin's *jointed* locomotive to *treble* its former power, with *less* wear and tear to machine and road.

3d. A full complement of cars adequate to the delivery of one million of tons per annum.

4th. Ample wharf accommodation for venting two millions of tons per annum, if required.

5th. The toll on coal in place of $1 to 1,25 per ton, will be raised to $1,37 to 1,50 per ton.

6th. *A double track* of solid railway the whole length of the line, imparting to all these advantages despatch and regularity; and as their final and collective consequence, producing an economy never before realized on any other railway in the world, moving such a mass.

It is now certain that 8 to 900,000 tons of coal will descend the Schuylkill avenue in 1844, and with only a moderate increase, it may be expected that 1,000,000 of tons will descend it in 1845. Of this quantity the railway will have the carriage of at least 7 to 800,000 tons, to which it will be fully competent. The result for that year, on the above premises and assuming that the proprietors of this road will see the advantage of exclusively

and at once adopting Baldwin's improved motive power, would then be somewhat as follows. It is a case, which will be found an *exception* to the prudent rule of stopping to count the cost.

Coal, 800,000 tons (equal to 2700 tons per day for 300 days) at an average of $1,40 per ton, - - - - - - - -		$1,120,000
Travel and merchandize, $15,000 average per month, - - -		180,000
		1,300,000

EXPENSES.

Transporting coal at 25 cts. per ton, - - - -	200,000	
do. travel and merchandize at 25 per cent. - - -	45,000	
Maintenance of way at $700 per mile of double track, -	70,000	
General charges, - - - - - - -	65,000—	380,000
		$920,000
Interest on $6,500,000 of loan at 6 per cent. - -	390,000	
do. 1,000,000 do. 5 per cent. - - - -	50,000—	440,000
Capital, 2,000,000 (equal to 24 per cent. for contingencies and dividend,)		$480,000
$9,500,000		

In explanation of what is meant by Baldwin's improved motive power, subjoined is an estimate of its cost per ton, compared with that of the old mode of transportation as collected for *this road.*

Items of expense.	Common 8 wheel 12 ton engine. Wooden cars.	Amount.	Jointed 6 wheel 16 1-2 ton engine. Iron cars.	Amount.
Engine drivers pay,	2 days, $2 per day,	$4,	same	4,
Fireman's do.	2 " 1,25 "	2,50	do. 2	5,
Conductors do.	2 " 1,30 "	2,60	do.	2,60
Brakeman's do.	6 95 "	5,70	do. 8	8,
Fuel,	wood and coal mixed	18,	do.	22,
Oil for engines,	2 galls. 86 cts.	1,72	do. 2 1-2	2,15
Repairs engine & tender,	180 ms. pr trip 6 cts.	10,80	do. 5 cts.	9,
Repairs cars,	185 ts., w'd c'rs 9 cts.	16,65	500 tons, iron cars 5 cts.	25,
Oil and grease for cars,	do. 1 1-4 cts.	2,31	do. 12 1-2 cts.	7,50
Supplying water,		50		65
Renewals of sundries,		1,72		4,25
Proportion of assist. engine at 1 mile 42 feet grade,		2,50		2,65
Cost of a trip of 2 days or of 180 miles,		$69		$93,
Gross load of train,	340		775	
Number of cars hauled,	56 of 1 1-3 tons each,		100 of 5 tons each.	
Net weight of coal,	185		500	
Making a cost per ton of,	37·30 cts.		18·60 cts.	

The improved jointed Baldwin engine of 16½ tons is guaranteed by the builders to haul 500 tons at a trip as its regular load and to that it will ultimately be appointed. These engines could thus be made to deliver *one million* of tons running *three hundred and sixty thousand* miles, while with the old ones, it would require *ten hundred thousand* miles, that is, in the one case barely one ton is carried to the mile run, while in the other, it is nearly *three* tons. The above comparative table of items shows that, on this new system of transportation, that 25 *cents per ton for motive power and wagons* is a full charge for the road.

It is not long since that ridicule was the sure portion of him who asserted that the freight of coal on this road would not cost over 55 cts. per ton, while now, thanks in good part to Messrs. Baldwin and Whitney, it has been reduced down, to from 30 to 25 cts. per ton. It is gratifying to know that this valuable invention is properly appreciated, and that they now have

their hands full in the manufacture of these admirable machines, from 8 tons up to 20 tons, for many of the railroads in the United States. Their workshop now gives employment to 350 hands.

The character, capacity and general appointments of this railway are therefore such, that if it ultimately costs ten millions of dollars it will be a cheap machine at that rate; and if from the untoward circumstances of the times through which it has been completed, this cost has been largely but unavoidably swelled, the expense of working it, has been more than proportionally cheapened, as compared with the original estimates.

Philadelphia, Sept. 1844. F.

RAILROAD CONVENTION.

A convention of citizens from Vermont, New Hampshire and Massachusetts was held in Boston, at the Tremont Temple, on Friday the 20th of September, for the purpose of calling the attention of the citizens of *Boston* to the continuation of the *Fitchburgh* railroad to Connecticut river, and thence to Burlington, Vt. There were many delegates present, representing the whole line to Burlington; and for a part of the way *several* routes were represented. *Abbot Lawrence*, Esq., of Boston, was called to preside, and on taking the chair, he made an address very appropriate to the occasion, which occupied but a short time in its delivery—as he said time was precious—and was to the point. He spoke of the advantages which Boston had derived from railroads, and of the importance to Boston of extending the system where it can be done, and especially into Vermont and to Burlington, that there may be a direct, easy and rapid communication with the capital of Canada. He said that on reading the report which had been put into his hands, he came to the conclusion that it was his *duty* as a citizen of Boston to subscribe $10,000, that he owed it to the people of Boston and therefore he decided to take that amount of stock; but on reading the letters of the Hon. Charles Hudson, in relation to the advantages of the road, a gentleman in whom he had the utmost confidence, he had come to the conclusion to subscribe $20,000 *more* as an *investment*, and he was ready to do it.—When a little sectional feeling seemed to show itself in the discussion, he urged the gentlemen to avoid anything which might defeat or defer the object of the meeting, as he thought the present was *the* time to press forward this work, so important to Boston. A committee of fifty gentlemen were appointed to take the matter in hand and obtain subscriptions to the stock, which will undoubtedly be done, notwithstanding there has been over $1,-250,000 of railroad stock already subscribed in Boston since January, 1844. Had New York but a few men like Abbot Lawrence to *lead*, we should soon have a railroad to Albany and another to *lake Erie*.

AMERICAN RAILROAD IRON.

We recently visited the Mount Savage iron works near Cumberland in Maryland, mainly for the purpose of ascertaining what progress they had made in the manufacture of railroad iron. We found the work fairly commenced, a large quantity made and they were then about to commence working

a double set of hands—that is to say, day and night. The rails then on hand, which are of the "bridge" form, 48 lbs. per yard, or a part of them, were to be laid on their own road, to connect with the Baltimore and Ohio road at Cumberland, about ten miles, which will thus open the way to send the bitumenous coal to market at a cheaper rate than it has hitherto been afforded at.

The works of this company now in operation and nearly ready for use, appear, to one unused to such operations on a large scale, quite extensive; yet we were informed that only a small part of the contemplated works are built. Two large smelting furnaces are completed, one was then, and the other would be in a few days, in blast. A large rolling mill with eight or nine puddling furnaces in full operation and with which they were making railroad and other iron at a rapid rate. There was also nearly completed a large building for nail works and another for a cupola furnace. Dwellings for about 500 laborers, and a large storehouse completed and in use, constitute the present establishment, forming quite a village in the midst of the forest and surrounding hills which rise several hundred feet above the lofty chimneys in every direction.

The position for the works is admirably chosen, at the base of the hill, where it is so steep that a short bridge serves to connect the mouth of the furnace with the building in which the ore is prepared; and still the descent from the ore bed is so great that they are brought down to the furnace mainly by gravity.

The quality of the coal of this region is admitted to be at least equal, and by *many* deemed superior, to any other bituminous coal used in this country; and the iron ore found in its immediate vicinity is considered by good judges of superior quality—and the supply of both is believed to be inexhaustible—therefore we are induced to believe that at no distant day, the "Mount Savage Iron Works," will become celebrated, as well for the quality as the quantity of it iron—and especially for it railroad iron—and that, with other establishments, especially in Pennsylvania, which are now preparing to engage in the manufacture of railroad iron, we shall be able in the course of a year or two at farthest to make all the iron—and it will not be a small quantity—which we shall require in this country.

We shall refer again to these works in our next number and to the subject of the manufacture of railroad iron in this country—a subject in relation to which much will probably be said and written within the next twelve months.

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AMERICAN RAILROAD JOURNAL, AND MECHANICS' MAGAZINE.

Published Monthly at 23 Chambers-st. New York, at $2 a-year, in advance, or 3 copies for $5. | D. K. MINOR, Editor.

No. 11, Vol. 2. Third Series. | NOVEMBER, 1844. | Whole No. 442. Vol. XVII.

NORTHERN RAILROADS.

The highly respectable meeting which took place at Boston on the 20th ult., of which we gave a sketch in our last, offers strong evidence of the estimation in which railways are held by an intelligent community as well acquainted with their working as any other—more so than any other in this country we may safely assert. The most striking feature was the calm, business-like view taken of the project, the care with which the cost had been ascertained, the thorough examination of the sources of income, and lastly the additional traffic which might reasonably be expected from the—sooner or later—inevitable extension of the road to Burlington on lake Champlain. There was no false excitement, no promises of 20 per cent. dividends; but the object was to state everything connected with the propo-sed undertaking so clearly and fully, as to enable every one to judge with confidence whether it offered sufficient inducement to warrant a permanent investment. Indeed it is with this view only that railways are constructed in Massachusetts, and the success which has thus far attended them is of course the most powerful possible argument for their still further exten-sion.

The income of the road as well as the comparative merits of different lines in this respect were very ably discussed in three letters of the Hon. Mr. Hudson, which, though not free from error, are, on the whole, at least equal to any other papers which we have seen, having for their object the exposition of the advantages of a contemplated public work. They attrac-ted much attention in Boston and have had great influence with those desi-rous of investing their means in railways. Their effect will therefore not be limited to the extension of the Fitchburg railway, but will be generally felt in their influence on the railway system of the commonwealth, "the only successful system of public works in this country," whose success we may safely ascribe to their being conceived in the spirit which pervades Mr. Hudson's letters, "the adaptation of expenditure to income" as one of their

correspondents defined it when discussing the merits of another system of public works on the same principles.

There is great reason to believe that the stock of a railway through Massachusetts to the Connecticut river will be very shortly taken up. At the above meeting held in Boston, delegates attended from all parts of the country which any of the proposed lines were likely to pass through. Although a strong spirit of rivalry showed itself among them, we are glad to know that the best spirit prevails among those to whom we must look for the means. The great object of the road appears to be to strike lake Champlain at Burlington by the best route. On this point there is of course great diversity of opinion, but it appears to us that the greatest influence will favor a route avoiding New Hampshire, not only on account of the "peculiar institutions" of that benighted country, but also with the object of striking the Connecticut river as low as possible so as to secure the trade of that valley to the greatest possible extent and then to take a north-west course to Burlington. We alluded in our September number to the advantages of this route over that direct to Montreal by lake Memphremagog and the "Eastern Townships," and we find our views more than borne out by the views given by the numerous able speakers at this meeting. The direct line to Montreal was scarcely alluded to, and as they propose crossing the Connecticut near the south line of the State, it leaves the advocates of that line under the necessity of building a road up the valley of that river the whole length of the State of Vermont. So far therefore as Boston is concerned the line to Burlington will receive an undivided support and we consider its construction pretty certain.

The main sources of income relied on are the travel and trade of the country on the line of road. In addition to this however they will secure ultimately a large portion of the trade of lake Champlain and of Lower Canada now coming to New York. They look forward also to a new route to the west via Ogdensburg, and to the allowance of a drawback on foreign goods exported to Canada. But the trade and travel of the country itself will yield a fair income for the capital invested.

It is fortunate that the powerful aid of Boston is now enlisted in favor of allowing a drawback on exports to Canada and within a year or two the requisite permission will be wrung from congress. Then the trade of Upper Canada, the most valuable portion, will centre mainly in New York, while the trade and travel of the Lower Province will naturally centre in Boston when the railway to Burlington shall be completed. We again express our surprise at the indifference with which the completion of the line to Whitehall is regarded in Boston as well as in New York. We say in Boston for it would materially aid their Western railway, though it would not be able to compete with the line from Burlington either in cost or time. By this latter route Montreal will be brought within 24 hours of Boston, while it would appear impossible to reduce the time between New York and Montreal to less than 36 hours. The railway from Syracuse to Oswego will

bring the entire shore of Ontario within from 30 to 36 hours of New York and will complete the main lines of "Northern Railroads."

The excitement is by no means confined to the States of Massachusetts and Vermont, but extends to New Hampshire, Canada and even to Maine. The Portland Advertiser contains a well written letter signed 'P,' which gives a general sketch of the public works of Canada and draws attention to the advantages of a railway from Montreal to Portland, the entire distance being 246 miles, or only 20 miles further than from Boston to Burlington. The writer also says that "Boston may be reached by the way of Portland as easily as by Concord, and by 29 miles less of road to be built." He has made some mistakes in the dimensions of the Welland canal, but, on the whole, makes out a good case for Portland were the question simply, which is the best route from Montreal to an Atlantic port open throughout the year, irrespective of way business, of existing railways, of established lines of steamers, of the interest and competition of Boston, etc. We have already stated that, in our opinion, the capitalists of Boston will give a decided preference to routes in their own State, hence a rival route to the north must not only not depend on that city for capital, but must actually be able to enter into competition with its numerous powerful companies for the traffic of the north. It is useless to look to Montreal at this time. Ship canals are the order of the day there and railways are considered beneath their notice. Boston holds the balance in this matter, and will unquestionably select that route which offers the greatest immediate return and the greatest ultimate benefit to that commonwealth of citizens, far surpassing in enterprize and energy all the other States of the Union and, in proportion to wealth and population, rivalling England itself.

PUBLIC WORKS AT AND NEAR LIVERPOOL.

Probably there are no places in the kingdom, not even excepting the metropolis, where a larger amount of money is in process of expenditure in the construction of public works than there is at this moment in Liverpool and Birkenhead. Almost in every direction on both banks of the Mersey huge preparations meet the eye; and, without entering into details, which would necessarily occupy much space, some idea of their extent may be gathered from an outline of the expenditure. In some of the following items the estimates include the cost of land. In Liverpool there are the following works now in progress: Assize courts (corporation,) cost £80,000; new gaol (corporation,) cost £100,000; Albert dock and warehouses (dock committee,) £600,000; new North Dock Works, including land and junction with Leeds canal (dock committee,) £1,500,000; reservoirs, Green-lane, and corresponding works (highway commissioners,) £50,000; Industrial Schools at Kirkdale (select vestry,) £30,000; gas extension (new gas company,) £140,000; Shaw street park (private shareholders,) £2,500; making a gross total of £2,500,000. All this is, of course, independent of many other works, some in progress and others in contemplation, with prospects of almost immediate commencement. Among those in progress may be reckoned Prince's park, now forming by Mr. Richard Vaughan Yates, at the south end of the town; the new Presbyterian church in Myrtle street;

the female orphan asylum, the Catholic female orphan asylum; the new northern hospital (towards which Mr. W. Brown recently contributed £1000;) St. Martin's schools, the Catholic magdalen asylum at Much Woolton, and St. Mary's Catholic church, in Edmund street. Besides other works in contemplation, we may mention the Daily Courts, on the site of Islington market (now discontinued;) the intended additional railway tunnel to the north end of the town, by the Liverpool and Manchester railway company; an additional merchandize station for the Grand Junction railway company; the enlargement of the Line street terminus; and some improvements on the Bridgewater property. These various works altogether will probably absorb not less than another million. So that, in the whole, between three and four millions of money will have to be raised and expended before the various present designs for the promotion of charity, the convenience of commerce, and the improvement of the town, are completed. But, if much is going on in Liverpool in this way, more, in proportion to population and means, is doing on the Cheshire side of the water, at Birkenhead. Here indeed a town is rapidly rising, which will not be excelled in useful or ornamental elements by any place in the kinghom; and the progress of which, in buildings, as well as inhabitants, during the last four or five years, has been unprecedented. The magnitude of the public works in progress at Birkenhead may be inferred from the following abstract which is taken from the estimates: New market (commissioners,) £20,000; town hall (commissioners,) £10,000; park (commissioners,) £25,000; docks in Wallasea pool (commissioners, as trustees,) £400,000; dock warehouses on the margin of Wallasea pool (private company,) £600,000; tunnel from Monk's ferry to Grange lane (Chester and Birkenhead railway,) £20,000; making a gross total of £1,075,000; and, further, a proposal has been made which is now under the consideration of the finance committee of the Liverpool corporation, to buy the freehold of all their Wallasea estate, and pay for it in ready money! Besides the works named as being in progress, a cemetery and infirmary are contemplated, to which may be added a design for the erection of one or more churches. On the two former we believe it is intended to expend about £15,000. In these items me have said nothing about the sums being expended in sewerage and laying mains for water and gas; they are very large, and in this present year they will exceed any of the past. After these statements, it will be admitted, we think, that there are very few, if any, places where the progression in works of a public nature is greater than in Liverpool and Birkenhead; and that, if there is any rivalry between them, it should only be as to which shall best accommodate the public.—*Manchester Guardian.*

Extraordinary Steamboat Expedition.—Five weeks ago Messrs. Ditchburn and Mare, the iron steamboat builders at blackwall, received an order to build another steamer for the Waterman's steam packet company, without delay, and entered into an engagement to complete her ready for the conveyance of passengers in five weeks. The plans and drawings were at once made, the keel laid down, founders, shipwrights, joiners, carpenters and others set to work, and on Saturday evening last, four weeks and four days only after the order was given, and the keel prepared, the new stemer, which is called *Waterman* No. 12, was launched and conveyed to Debtford, to have her engines and machinery fitted in her, Messrs. Penn and Son, of Greenwich having, in the same space of time, made and finished two oscillating engines, of sixteen horse power each, with boilers and machinery. At ten minutes before five o'clock on Monday evening, and twenty-four

hours before the expiration of the five weeks, the steam was up for the first time, and away started the vessel down the river, at a great speed. She is capable of carrying three hundred and fifty passengers and is a very handsome vessel of her class. *Waterman* No. 12 commences running between Woolwich, Greenwich and the Adelphia pier to-morrow. The fare to Greenwich has been reduced to 4*d.*, in consequence of the low fares charged by the Gravesend steamers.—*Railway Mag.*

Stonington Railroad.—The total receipts for the year ending Aug. 31, 1842, were - - - - - - - $95,435 47

For the year ending Aug. 31, 1843, - - - 113,889 31

For the year ending Aug. 31, 1844, - - - 154,724 02

This shows a very satisfactory increase in the business of the road, notwithstanding the competition of rival routes.

GENERAL DEMONSTRATION OF THE PRISMOIDAL FORMULA, USED IN EXCAVATION, EMBANKMENT, AND MASONRY CALCULATIONS: BY ELWOOD MORRIS, CIVIL ENGINEER.

In the number of this Journal, for January, 1840, the writer endeavored to develope a mode of measuring excavation and embankment solids, which upon the general *Hypothesis that the surface of all ground is composed of planes, longitudinally and transversely, and free from twisted surfaces,* may be regarded practically as accurate.

This method was made to depend essentially upon two points.

1st. That the formula, expressing the capacity of a prismoid, is the *fundamental rule,* for the mensuration of all right lined solids, whose terminations lie in parallel planes, and is equally applicable to each.

2nd. That any solid, whatever, bounded by *planes,* and parallel ends, may be regarded as composed of some combination of prisms, prismoids, pyramids and wedges, or their frustra, having a *common altitude,* and hence capable of computation by the general rule alluded to.

From these premises, the inference was drawn, that any such solid, (the middle section of which, parallel to the ends, could be ascertained) was susceptible of accurate determination: and consequently as the mid-section of any given portion of excavation or embankment, can be correctly deduced from the data, usually taken in the field, that therefore the capacity of these solid portions might be thus calculated. And we may here observe, that the same method is evidently applicable to masonry calculations, with even greater facility, as structures of masonry are usually composed of symmetrical solids.

The remarkable property of the prismoid, above alluded to, was established in connection with prisms, pyramids, wedges and frustra of pyramids, by a sinple inverse algebraic process, displaying the relation between the common rules, laid down by the writers on mensuration, and the prismoidal formula. But this formula, admits of a direct demonstration by the aid of the integral calculus, and of a more connected proof that it is the *fundamental rule* for the solidity of all right lined solids terminating in parallel planes.

As the paper on mensuration, before alluded to, relies upon the establishment of this property, it has occurred to the writer that it might be agreeable to some of the readers of this work, to have a direct developement of the principles, which that essay reduces to practice; and with this view, I propose, first, to establish the truth of the prismoidal formula, and then to trace up the dependence upon it, of the ordinary rule for the mensuration of other solids.

General Demonstration of the Prismoidal Formula.

Fig. 1.

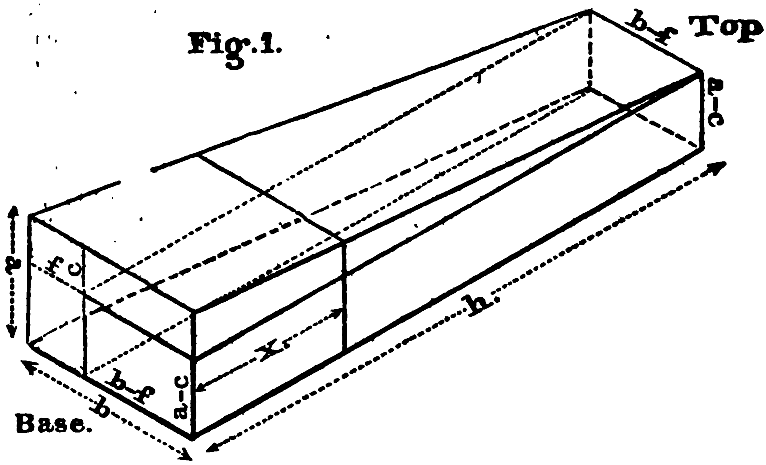


Fig. 2. Base = b.

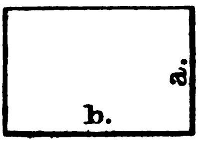


Fig. 3. Mid. sec. = m.

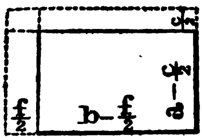
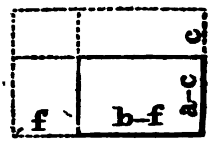


Fig. 4. Top = t.



Let fig. 1 represent a prismoid; fig. 2, the base; fig. 3, the mid-section; and fig. 4, the top. All the dimensions being designated, as marked upon the several figures.

The area of the base will be, (see fig. 2,) $a \times b = ab$.

The area of the mid-section will be, (see fig. 3,)

$$\left(b-\frac{f}{2}\right)\times\left(a-\frac{c}{2}\right)=\left(\frac{2b-f}{2}\right)\times\left(\frac{2a-c}{2}\right)$$

$$=\frac{4ab-2af-2bc+fc}{4}$$

Whence four times the mid-section: $=4ab-2af-2bc+fc$.

The area of the top will be, (see fig. 4,) $(b-f)\times(a-c.)$

$$=ab-af-bc+fc.$$

Any transverse section of this prismoid, parallel to its base, or top, will be a rectangle.

The lengths of the sides forming the rectangle of the top, are supposed to be less than those of the base, which correspond to them by the quantities f and c, respectively. And it is evident from inspection, that the sides of the rectangular sections, proceeding from the base towards the top, *diminish* as the distance of the section from the base *increases*.

Let x, be the distance of any section from the base, supposing it, of course, to be parallel to the base or top, then the diminutions in the sides of this rectangle, will be to the total diminutions in the ratio of x to h, or as $\frac{x}{h}$.

Therefore, generally, the area of any rectangular section of a prismoid, at any distance, x from the base, will be

$$=\left(a-c\frac{x}{h}\right)\times\left(b-f\frac{x}{h}\right)=\left(\frac{ah-cx}{h}\right)\times\left(\frac{bh-fx}{h}\right)$$

Whence expanding $=\left(\dfrac{abh^2-bchx-afhx+fcx^2}{h^2}\right)=$ area section.

Wherefore the element of solidity, or differential of the solid,

$$=\left(\frac{abh^2-bchx-afhx+fcx^2}{h^2}\right)dx.$$

$$\text{Whence } \frac{abh^2dx}{h^2}-\frac{bchxdx}{h^2}-\frac{afhxdx}{h^2}+\frac{fcx^2dx}{h^2}.$$

The integral of which will represent the capacity of any frustrum of a prismoid, whose length $=x$.

$$\int\frac{abh^2dx}{h^2}-\int\frac{bchxdx}{h^2}-\int\frac{afhxdx}{h^2}+\int\frac{fcx^2dx}{h^2}$$

$$=\frac{abh^2x}{h^2}-\frac{bchx^2}{2h^2}-\frac{afhx^2}{2h^2}+\frac{fcx^3}{3h^2}.$$

In point of fact, this integration produces a constant quantity, C, but as this = O, when we estimate the capacity of the solid, from the base, as we propose to do, we may neglect it.

Reducing to a common denominator, we have,

$$\frac{6abh^2x}{6h^2}-\frac{3bchx^2}{6h^2}-\frac{3afhx^2}{6h^2}+\frac{2fcx^3}{6h^2}$$

which is the general expression for the solidity of any frustrum of a prismoid, whose length measured from the base $=x$. Now to transform this expression, so as to apply to a whole prismoid, we must suppose $x=h$, and let $s=$ solidity:

Then substituting h for x in the above expression we have,

$$=\frac{6abh^3-3bch^3-3afh^3+2fch^3}{6h^2}$$

Or dividing by $h^2=(6ab-3bc-3af+2fc)\times\frac{h}{6}=S.$

Which expression may be transformed into the following,

$$\Big((ab-bc-af+fc)+(4ab-2bc-2af+fc)+(ab)\Big)\times\frac{1}{6}h=S. \text{(A.)}$$

We will call this equation A, and it is equivalent to

$$\Big(\text{(Area of top.)}+\text{(four times area mid. sec.)}+\text{(area of base)}\Big)\times\frac{1}{6}h=S.$$

See the areas of these sections as heretofore deduced. The above equation A, is in fact, the general formula.

$(b+4m+t)\times\frac{1}{6}h=S$ at which we desired to arrive, and the truth of which is established by the foregoing investigation.

To trace up now the dependence of the usual rules for the capacity of certain solids, upon the general formula, it may be premised, that of all right lined solids, bounded laterally by longitudinal planes, and terminated in two transverse parallel planes, we distinguish but *four* independent species, viz:

1. Prisms, which on account of the analogy subsisting between them, include cylinders.

2. Pyramids, which include cones, because cones, and pyramids of a common altitude, and equal bases, are equal.

3. Wedges.

4. Frustra of pyramids, which by analogy include frustra of cones.

To show that the general formula, is the *fundamental rule* for determining the solidity of these several solids, and by a necessary consequence, for the mensuration of any right lined solid whatever, made up of any combination of the four species, having *a common altitude*. We will take up,

1. *Prisms.*

These are in fact, prismoids, of which the end sections are equal and similar: and as all sections of a prism, parallel to the base, must be also equal and similar, therefore the sides of those sections do not diminish, and f and c, the diminutions of the prismoid, when it becomes a prism, vanish, or become $= 0$.

Substituting then in equation A, zero for f and c, we have,

$$\Big(\big[ab-(b\times o)-(a\times o)+(o\times o)\big]+\big[4ab-(2b\times o)-(2a\times o)+(o\times o)\big]\times(ab)\Big)\times\frac{1}{6}h=S.$$

$$\text{Which is equivalent to }\Big((ab)+(4ab)+(ab)\Big)\times\frac{1}{6}h=S.$$

$$\text{Whence, }(6ab)+\frac{1}{6}h=S.$$

Or, finally, $ab\times h=S.$ which is the usual rule for finding the solidity of a prism, or cylinder.

2. *Pyramids*

A pyramid may be considered as a prismoid, whose sides diminish by such a ratio, that if the solid were prolonged from the small end, the sides of the rectangular sections, would vanish at the same moment, or concur upon a point, (the vertex of the pyramid;) considering the prismoid at this instant, it is evident that the diminutions f and c, of the sides of the base, become equal to the sides themselves, and if the base of the pyramid be any rectangle $a\times b$, we must, therefore, in equation A, substitute a for c, and b for f; and we have,

$$\Big((ab-ba-ab+ba)+(4ab-2ba-2ab+ba)+(ab)\Big)\times\frac{1}{6}h=S.$$

$$\text{Whence, }\Big((o)+(ab)+(ab)\Big)\times\frac{1}{6}h=S.$$

$$\text{Or, }(2ab)\times\frac{1}{6}h=S.$$

$$\text{Or, finally, }ab\times\frac{1}{3}h=S.$$

which is, in fact, the common rule laid down in the books, for finding the capacity of a pyramid, or cone.

3. *Wedges.*

If we imagine the sides of the successive sections of a rectangular pris-

moid, to diminish by such a ratio, that if the solid were prolonged from the small end, they would not all vanish at once; then it will be found that when one pair of sides of the rectangular section disappears, the other pair will coincide, and become a right line, the solid in point of fact, will run to an edge, and the prismoid will be transformed into a wedge. Let the base, or back of any wedge, be any rectangle $a \times b$, and suppose in the prismoid fig. 1, the side a, to vanish, then it will become a wedge, of which $(b-f)$ = the length of the wedge; a = breadth or thickness of the back; b = the length of the back. And as the side, a, is supposed to vanish, it will at the instant of disappearing, become equal to c, its diminution.

Substitute, therefore, in equation A, a for c, and we have,

$$\Big((a\,b-a\,b-a\,f+a\,f)+(4\,a\,b-2ab-2\,a\,f+af)+(ab)\Big)\times\frac{1}{6}h=S.$$

$$\text{Whence, } (3\,a\,b-a\,f)\times\frac{1}{6}h=S.$$

$$\text{Or, finally, } \Big((b-f)+2b\Big)\times a\times\frac{1}{6}h=S.$$

But $(b-f)$ = "length of edge;" a = "breadth or thickness of back;" and $2\,b$ = "twice the length of the back."

Consequently, this expression is in fine, the common rule laid down, by writers on mensuration, for ascertaining the capacity of wedges.

4. *Frustra of Pyramids.*

We may regard these solids as prismoids, whose sides diminish by a regular proportion to their own lengths, such, that if the solid were prolonged from the small end, all the sides of the rectangular section, would vanish at once, and the solid become a pyramid. Therefore f and c, the total diminutions in the sides of the frustrum, or the quantities by which the sides of the top are less than those of the base, must have the same ratio as the sides themselves.

$$\text{Or, } f:c::b:a.$$

$$\text{Consequently, } b\,c=a\,f, \text{ and } f=\frac{b\,c}{a}.$$

Now in equation A, substitute $b\,c$ for $a\,f$, and $\frac{b\,c}{a}$ for f, and we have,

$$\Big((a\,b-b\,c-b\,c+\frac{b\,c^2}{a})+(4\,a\,b-2\,b\,c-2\,b\,c+\frac{b\,c^2}{a})+(ab)\Big)\times\frac{1}{6}h=S.$$

$$\text{Whence, } \Big(6a\,b-6\,b\,c+\frac{2\,b\,c^2}{a}\Big)\times\frac{1}{6}h=S.$$

$$\text{Or, } \Big(3\,a\,b-3\,b\,c+\frac{b\,c^2}{a}\Big)\times\frac{1}{3}h=S.$$

Which may be transformed into

$$\Big((a\,b-2\,b\,c+\frac{b\,c^2}{a})+(a\,b-b\,c)+(a\,b)\Big)\times\frac{1}{3}h=S.$$

But $\Big(a\,b-2\,b\,c+\frac{b\,c^2}{a}\Big)$ is the area of the top, when the prismoid becomes a frustrum of a pyramid. And $(a\,b)$ = area of base, while $(a\,b-b\,c)$ =

$$\sqrt{\left(ab \times \left(ab - 2bc + \frac{bc^2}{a}\right)\right)},$$

the square root of the product, of the end areas.

Wherefore, the above expression, is merely the usual rule for the capacity of frustra of pyramids, or cones, expressed in Algebraic language.

Besides the applications we have above given, of the prismoidal formula to the measure of solidity; it may be employed by simply substituting lines for surfaces, in the measurement of the superficies of triangles, parallelograms and trapezoids.

For a triangle may be regarded as a rectangular pyramid, of which one side of the base equals zero.

A parallelogram, as a rectangular prism, without thickness.

And a trapezoid, as a wedge on a rectangular back, the side of which is perpendicular to the direction of the edge, or in fact, the thickness of the back = O.

The prolific formula, of which we have been treating, has also, some other applications in mensuration, such as to determine the solidity of an Hemisphere, a Sphere, a Spheroid, either oblate or prolate, a Paraboloid, an Hyperboloid, and by a slight transformation, to calculate the surfaces of several bodies. But as all these are foreign to the present purpose, the writer does not propose to engage in their discussion.

Oldtown, Md., May 25th, 1840.

Reduction of Tolls.—It will be seen by the advertisement of the superintendent of transportation of the Baltimore and Ohio railroad company, that the charge for the transportation of flour from Harper's Ferry, Frederick and all points east of those places, has been materially reduced. From Harper's Ferry the charge will hereafter be 25 cents per barrel, and from Frederick and the Monocacy, the rate is reduced to 20 cents. We are heartily glad that this measure has been adopted, and we have no doubt that in due time it will prove itself to be both wise and profitable.

CANADIAN CANALS.

The two following tables contain numerous details which will prove interesting to our readers. They are from an official report for which, among other documents we tendered our thanks to the Hon. Mr. Woodbridge, U. S. senator from Michigan, in a late number of the *Journal*. The estimates are in 'currency' or four dollars to the pound. They amount to nearly 5 millions of dollars but do not include the sums expended before the establishment of the board of works, about four millions of dollars, making the total *estimated* cost nine millions for 88½ miles of canal, 59 locks and 537 feet lockage. This is about $100,000 per mile or more than the cost of the Reading railway complete for a down trade of one million tons per annum besides up freight and passengers in both directions 'ad libitum.' That is, the mere cost of these canals exceeds that of the Reading railway with a double track, buildings, engines, cars, wharves, etc., etc., for a trade about twice that of the Erie canal. We do not find a word of the revenue of the works in operation, the tolls charged and to be charged, or of the mode in which these canals are to cheapen transportation. The difference in dimensions are to us very curious, there being no less than five different

widths at bottom and six at the surface. The favorite dimensions for locks are 200×45×9, though the locks of the Welland canal are only 150×26½×8½ or in the ratio of 10 to 23. Now the Welland canal receives the New York trade as well as the Canada trade; the former exceeds the latter in amount; all freight in *both* directions must go by the Welland, while the river takes all the down freight from the St. Lawrence canals and the Rideau competes for the up freight. It appears therefore to us that the ratio should be inverted, that is, that the St. Lawrence canals should *at most* equal the Welland canal in dimensions of locks with a smaller channel to pass the nearly empty boats going up.

We believe the toll to be 20 cents per barrel of pork or $1,40 per ton, which would make the toll alone for 28 miles equal to 5 cents per ton per mile, a high price for the *total cost* of transportation on a railway doing a medium business. But great as is this charge and large the amount of produce passing the Welland canal, it will be long before it will have paid expenses and interest, even without any new rival.

It will afford us great pleasure to publish any communications giving a more favorable view of the prospects of these canals, for, in addition to their obvious disadvantages of immense cost and northern position, we confess that the communications of our correspondent on the "Canals of Canada" have not been without an influence which the case of the Beauharnois canal has not changed for the better. A statement of the income, expenditure, rates of toll, of transportation and of speed on these canals would be very acceptable. They are the only works of the kind in Europe or America, and their success or failure must powerfully affect the prosperity of the Province in general as well as the cause of public works there for many years to come.

There is one circumstance to which much importance is attached in this report: the low *cost per cent* of superintendence. This serves merely to cloak the most extravagant expenditures and gross professional incapacity. Suppose more competent men with twice the salary had executed better works for one half the sum; then the *cost per cent* for superintendence would have been four times as great though the public would have saved nearly half the total expenditure.

A low rate of superintendence estimated on the cost *may* prove economy in management; it *may* also prove great extravagance, the employment of cheap and incompetent engineers or, admitting their capacity, it shows generally that the work executed at the least cost per cent for superintendence either requires less engineering or has been more or less neglected. For example, it is about as easy to stake out a canal 10×140 as one 4×40 like the Erie canal though the difference in cost is nearly ten times. The whole system of these government canals rests, however, so exclusively on the "ad captandum" that it appears almost ungenerous to pull away this last leg left them to stand on.

	£	S.	D.	£	S.	D.	£	S.	D.	
Welland canal,	500,000	0	0	495,366	0	3	129,562	12	0	December, 1845
St. Lawrence canals,	768,535	11	2							
Prescott to Dickenson's landing,				168,124	8	11	243	4	0	December, 1845
Cornwall, to the time of opening the canal in June, 1843,				57,110	4	2	57,110	4	2	Compl'ted the banks being strengthened.
Cornwall, to repair breaks in the banks since the above period,				5,102	18	9	5,102	18	9	
Beauharnois,				247,521	18	4	68,856	13	0	May, 1845
Lachine,				250,333	6	8	16,109	12	11	December, 1845
	1,268,535	11	2	1,223,558	17	01	276,985	4	10	

CANALS.		Length in miles	No. of locks.	Lockage in feet	Size of locks. Length of chamber.	Width.	Depth on mitre sill.	Width of canal. At bottom	At surface	REMARKS.
					Ft.	Feet.	Feet	Ft.	Ft.	
The Welland canal,										This canal has two entrances in lake Erie, Ports Maitland & Colborne; and also communicates with the Grand river navigation at Dunnville. The lake at Port Maitland is open some weeks earlier in the spring than at Port Colborne or Buffalo.
Main trunk from Port Colborne to Port Dalhousie,		28	31	328	150	26 1-2	8 1-2	45	81	The whole of these works are under contract; several of the locks will be completed this season, and the entire line will be available in 1845. The navigation of the old canal being preserved uninterrupted in the mean time.
Junction branch to Dunville,	not added below.	21	1	6	150	26 1-2	8 1-2	35	71	
Broad creek branch to Port Maitland,		1 1-2	1	6	200	45	9	45	85	
The St. Lawrence canals,										
Galops and Port Cardinal,		2	2	7	200	45	9	50	90	The surveys and other details of these works are now prepared, and they will be advertised immediately, and ready for navigation in 1845.
Rapid Plat,		4	2	11 1-2	200	45	9	50	90	
Farren's Point,		3-4	1	3 1-2	200	45	9	50	90	
Cornwall, passing the Long Sault rapids,		11 1-2	7	48	200	55	9	100	150	Completed, and in operation. The banks are being strengthened.
Buharnois, do. Coteau, Cedars and Cascades road,		11 1-4	9	82 1-2	200	45	9	80	120	In progress. The work rapidly advancing, and will be ready for navigation in the spring of 1845.
Lachine, do. Lachine rapids,		8 1-2	5	44 1-2	200	45	9	80	120	Surveyed but not yet put under contract.
Total from lake Erie to the sea.		66	57	535						The whole distance from lake Erie to tide water is 520 miles.

All these canals will be completed before the opening of the navigation in the spring of 1846.

There are a great number of minor works which swell the total estimated cost to £1,761,721, exclusive of large sums expended on the Welland, Cornwall, Lachine, Chambly canals and perhaps some minor works, which in the aggregate must reach five millions of dollars. The total cost will therefore be twelve millions of dollars as *estimated*, but if they are *completed* for fifteen millions the Province will be much more fortunate than the State of New York has ever been since the opening of the Erie canal. Whether those works will soon or ever be completed is a question we do not hazard an opinion on, but in any event we think the information conveyed in the tables will be generally acceptable to our readers.

(A considerable sum, about $260,000, is to be expended in deepening lake St. Peter, between Mantreal and Quebec, but this will not affect the western trade, for, should that ever become very important, the trans-shipment will of course take place at Quebec, as it will only cost half as much to run the light barges with their heavy cargoes to that port as to bring heavy sea vessels to Montreal to load them.)

ALLAN'S MINERALOGY.

The deep cuttings and tunnels on the numerous public works of the present day afford the fairest opportunities for the study of mineralogy as well as of geology. By means of the latter science we acquire a knowledge of the peculiar earths or rocks likely to be encountered in certain localities, and mineralogy teaches us the chemical constituents of these substances. In a general reconnoissance of a country such as *ought* to precede all instrumental examinations the general arrangement of the strata is the great consideration; but when the construction is to be commenced, the properties of the various earths to be removed and of the stones to be used in building must attract the attention of the engineer. In these important investigations he will be materially aided by the very valuable edition of Phillips' Mineralogy, edited by Francis Alger, Esq., a scientific gentleman of Boston and lately published in this city. This is not one of those re-publications to which the American editor contributes only the sanction (!) of his name in large capitals on the title page; but it is just what it professes to be, the best English elementary treatise on mineralogy with the latest European additions to the science as well as the numerous and very valuable contributions of the extensive geological surveys which do honor to the States by which they have been authorized. The publishers say:

"Phillips's Mineralogy has proved the most popular treatise on the science ever published in Great Britain. Prof. Brande, of the Royal Institution, London, thus speaks of it. 'One of the most useful practical works on mineralogy, and, in our language at least, the most available for the use of the student, is Mr. Allan's edition of the elementary treatise by the late Mr. Wm. Phillips.' Its circulation in this country has also beeu very extensive. The present edition comprises three hundred more pages, and the

hundred more figures of crystals, and about one hundred and fifty more species and important varieties, than are contained in Allan's edition. Notwithstanding these additions, the price of the book is considerably less than Allan's, or any other recent treatise on the subject.

"For the convenience of those who may wish to arrange their cabinets on a chemical system, several hundred extra copies of the formulas have been struck off, and will be sold at the cost of printing. These can be conveniently cut apart and pasted upon the specimens.

"We would add, that this work has been approved by Prof. Webster, and adopted by him as a text book in Harvard college; the splendid cabinet in that institution, having recently been re-arranged by him, in accordance with the same system."

THE LONDON AND BIRMINGHAM RAILROAD,

Is 119 miles in length. It cost £6,002,452, or thirty millions of dollars. It is well managed. The expenses, proportioned to the receipts are only 32 per cent. with a mixed traffic of passengers and freight. The receipt from the former, proportioned to the latter is as three to one.

The receipts for	1842	were	£809,247
"	1843	"	818,522
Six months	1844	"	405,768

These receipts average £813,000 per annum for 3 years and are double the amount received per annum in this State, for tolls on all our canals, of six times the length of this road. The original cost of these canals, were not half the cost—a little over one third—of this road of 119 miles.

This road contends successfully with a canal (the Junction) that runs side by side with it. The receipts and value of the canal has fallen off full 50 per cent. while the railway stock is £225 for 100 paid, and divides regularly ten per cent. per annum.

The British government allow this road £14,700 per annum, or at the rate of $600 per mile per annum, for her penny mail which now nets the government $3,000,000 per annum. J. E. B.

NEW PROPELLER.

A friend and frequent contributor obliges us with the following particulars of the mode of construction and performance of Aldrich's vertical submerged paddle wheel.

"We were indebted to the proprietors of the Atlantic Works for a pleasant excursion down the bay, on an experimental trip, in the Orion, a vessel of 150 feet between extreme points, 140 feet keel, 25 feet beam and 10 feet hold, 350 tons.

"Messrs. Allaire and Aldrich who accompanied us, stated that the form of the vessel was not such as they would have desired for the engine, for speed, and they were limited, as to space, to make her an effective freight-carrying vessel. The owners of the hull selected their model, and if the small vertical wheel did not work, it was to be taken out with the engine, and the loss was to fall on these enterprising mechanics. It is therefore gratifying to record that this essay was perfectly successful, taking into view the fact that everything was new. The boiler generated foam faster than steam, which, forcing itself into the cylinders, caused us to stop several times, to

blow off water. This defect we believe is common with new boilers. It was difficult to keep up, from this cause, 30 to 40 revolutions. To give full effect to the wheels, it is desirable, and they can be made to revolve from 55 to 60 times to the minute.

"To give you some idea of our speed and the distance run, I would state that we left the Atlantic Works at 11, A. M., with Mr. Henderson, pilot, and run down the bay and past the Hook to 'south the Cedars,' a distance of 25 miles, the tide favoring us, but with a strong wind against us. On our return, we marked the time from Fort Hamilton up to the Dry Dock wharf, opposite which we arrived at 4.20 P. M., making 12 miles in the hour. The average of the above is ten miles, with a two mile current, if we take off 45 minutes for stops, to blow off the water in the cylinders, and to get up fires of anthracite coal.

"The wheels are made water tight, of boiler iron, seven feet five inches diameter, twenty inches wide. On the species of drum are placed iron buckets, 14 inches deep, thus making the whole wheel but 9 feet 9 inches, to propel a vessel of 350 tons. One of the great merits claimed for this wheel is, that it is placed within the frame of the vessel, in a species of water-tight bunker, and is no impediment, except the revolving motion of the small wheel, when thrown out of gear.

"The whole apparatus is placed in a space of about 22 feet square. The boiler is 18 feet long by 6 feet diameter. There are two cylinders, 20 inches in diameter, with a thirty inch stroke, one on each side of the boiler acting directly on the crank.

"It was the wonder of all on board, when the steam was once raised to 42 revolutions, to notice her performance."

The engine and paddle wheels were from the well known establishment of Mr. Allaire. One of the advantages of this wheel is that it may be made so as just to float without bearing on the boxes. The present wheels bear on the upper box. It will be distinctly seen that the friction is reduced to a minimum when working, and, when sailing, with the wheels out of gear, the retardation must be very small—insignificant as compared with the ordinary paddle wheel or Ericsson's propellers. The breadth of beam is not increased; this is a great consideration with sea-going vessels as well as with canal boats, unless the vertical wheels work too near the bottom to be applicable to the latter.

The Allaire works are very extensive and are to be considerably increased. They employ above 200 men and do all the work connected with steam engines and other heavy machinery within themselves. It is on such establishments that we must rely for steam ships to extend our commerce in peace and to defend our harbors in war. It is of the want of such establishments in France that the Prince de Joinville complains so loudly and without which he very properly concludes, that rivalry with England either in peace or in war is impracticable. A very slight inspection of the Allaire works will convince any one of the expense, skill and method necessary in such concerns and of the difficulty attending their establishment in the first place. Luckily this country now boasts many such, considerably in advance of other nations—England of course excepted—both as regards skill and capacity. We give in this number an example of quick work in Eng-

land, than which nothing can better illustrate the importance in every point of view—commercial as well as military—of these large and well conducted private engineering establishments.

GREAT WESTERN RAILWAY OF ENGLAND.

That some idea may be formed of the cost of this work compared with railways in this country, I would state from the last report, that 119 miles exclusive of the Cheltenham and Oxford branches, cost £6,705,112, or $33,525,560. The following, in round numbers, at $5 to the £1, compose the items of this immense expenditure.

	Total.	Per mile.
Law expenses and procuring act of incorporation,	$950,000	$8,500
Land for road bed, - - - - -	3,960,000	33,560
Engineering, - - - - -	775,000	6,568
Grading, - - - - - -	18,835,000	159,610
Superstructure, - - - -	5,600,000	47,457
Motive power, - - - - -	3,018,750	25,582
Incidental and office expenses, - - -	386,810	3,276

or at the rate of $284,000 per mile.

On this immense expenditure this road now pays 7 per cent. The company procure loans at an extended period at 3½ to 4 per cent.

The capital authorized is, - - - - -	£3,673,603
Authorized to borrow, - - - - -	3,679,343

The width of the track is seven feet. The average velocity with the mails, for which the government pay $400 per mile per annum, is 35 miles per hour.

On the London and Birmingham road the British government pay $600 per mile per annum for a less rate of speed, but for a greater service. The mail service on other roads and branch roads in England, varies from $200 to $600 per mile per annum.

The total receipts for		1842,	were - - -	£669,535
"	"	1843	" - - -	707,522
6 months,	"	1844	" - - -	369,259

The expenses, proportioned to the receipts, were 39 per cent. in 1842; 36 in 1843; 34 in 1844. The receipts from passengers, proportioned to receipts from freight and the mails, was as 3 to 1. The whole number of passengers transported during 1843, was 1,629,159. The average number daily, 4500. The number of miles travelled in 1843 = 53,942,124.

This immense business, = £740,000 per annum, is more than double the average tolls received on all the canals in the State of New York for three years past. These receipts do not equal the average amount received per annum —£813,000—for the last three years from the London and Birmingham railroad (119 miles) in length. An amount, that shows the importance of that road and the Western railroad to the travelling and trading community of Great Britain. The average speed of railways, over coaching, is in the ratio of 4 to 1, when stops are included. The rates of freight, both

by canals and teams have been reduced, since the introduction of railroads. This great improvement has enabled the British government to introduce the penny postage system, with a nett profit of $3,000,000 per annum, rapidly increasing.

☞ Will the government of the United States profit by this example and secure in time, the right to use the several State incorporations, on equitable terms, compared with the service they can render the government.

J. E. B.

Mr. C. Williams, "a farmer of old Suffield, Mass.," has published a very sensible letter on the Massachusetts and Vermont railroad, in which he draws attention to the saving which would result from connecting Brattleboro' with Boston via Springfield and the Western railroad in place of extending the Fitchburg road to that village. He says:

"It may be well, for a moment, before it is concluded that the valley road is an object without inducement, and to be abandoned for the sake of a connection with the Massachusetts and Vermont road, by means of a branch road, to count the cost of the two enterprizes, and the comparative probabilities of their completion. The Northampton and Springfield road may be practically considered as completed. The distance from Northampton to Greenfield by railroad line is 18¾ miles, of which eleven miles are straight over a sandy plain, where the deepest cut will not be more than eight, and the heaviest filling twelve feet. The rest of the line has but little curvature and is very feasible. The estimated cost of the road with a T rail of fifty eight pounds to the yard is $275,000, and the road can be completed in one season.

"The distance from Greenfield to Brattleboro' is 19 miles, and the cost of a railroad cannot exceed $20,000 per mile, or about $380,000 for the whole distance.

"Thus it appears that the cost of connecting Greenfield with Boston by the Western railroad, will be $275,000 and of connecting Brattleboro' $655,000; the distance from Brattleboro' to Boston by Springfield, being 154 miles.

The cost of connecting Brattleboro' and Greenfield with Boston, by means of the Massachusetts and Vermont railroad, will be according to the estimate, by way of Northfield, $1,655,303, to which add the cost of a branch to Greenfield, $222,000, and we obtain the cost of uniting these towns with Boston, $1,877,303. Distance from Brattleboro' to Boston by the Fitchburg railroad, via Northfield, is 117 miles. Outlay necessary to save the distance of 37 miles upon a railroad, which may be run in less than two hours, $1,222,303.

WOODEN RAILWAYS FOR IRELAND.

The late elaborate report of the Irish railway commissioners of 1838 has no doubt elicited many plans for applying and supporting an economical system of intercommunication by railroad in Ireland. Among the most deserving of attention of these is one contained in a letter recently addressed to the Irish railway committee of the house of commons by Mr. Bridges, in which that gentleman applies himself with much practical knowledge of the subject, to prove that a system of wooden tramways, equally expeditious and more safe, more durable, and considerably more economical than the iron railway, might at once be introduced into Ireland, to the mutual benefit

of the English, Scotch, and Irish capitalist, merchant and laborer. In conveying to our readers a notion of this plan we shall avail ourselves of portions of Mr. Bridge's letter, and thus describe its details:

"The rails, or rather trams of 7 to 8 inches scantling, are indurated and protected against the ordinary destructive agencies of fire, rot, and insects, by a very philosophical process, to wit, the injection, by successive exhaustion and pressure, of two solutions, mineral and alkaline, which, by decomposition, transmute the timber into a new and incorruptible substance. These trams are laid down on the principle of the 'double way' of the ancient tramroads, which is also the modern principle of the Great Western railway; that is to say, they are let into wooden transverse sleepers, and secured thereon by wedges, forming one great frame of longitudinal and cross sleepers, on the level surface of the ground. The tires of the wheels are perfectly flat, and before and behind each carriage two guide wheels (the Prosser guide wheels) are fixed at an angle of 45 degrees, revolving upon independent axles; a deep groove in their circumference embraces the upper and inner edge of the trams, and the friction being thus thrown upon the oblique axle, the carriages are guided with perfect safety, and without any perceptible abrasion of the rails. The friction and oscillation, and general wear and tear involved in the use of the conical tire and the flange, are thus obviated; and the friction of attrition is converted into a friction of rotation. All the wheels, moreover, are on separate axles, so that in a curve, the inner and outer wheels adapt themselves necessarily to each sinuosity; on the present system of common axles, the outer wheel revolves while the inner one is dragged along upon a curve. Upon a level, experiment has proved that one-fourth less power is required to move an equal weight upon a railway of this construction than upon the flanged wheel carriage of an iron rail; at the same time, the bite of the wood affords a greater power of ascending gradients, and the bevel wheels give the facility of traversing the sharpest curves. A machine of seven tons can thus mount and descend gradients of less than 1 in 20, and traverse curves of 500 feet radius at the rate of 25 miles an hour. On the one hand, the durability is attested by the fact that wood properly prepared has recovered the deflexion occasioned by the pressure of 140 tons upon a segment of an iron wheel three inches in the tire, and that an experimental traffic equivalent to seven years of an ordinary line did not obliterate the sawmarks upon the wooden trams, which on the contrary actually polished the bevelled surface of the guide wheels. While the guide wheel is equally applicable to the ordinary iron railway, a peculiar advantage, besides that of primary economy, in the use of the prepared longitudinal beams, is to be found in the action of the deliquescent salts which entre into their preservative composition, and which effectually prevent slipperiness from frost, and from the opposite extreme of intense summer heat.

"The superiority of longitudinal sleepers over stone blocks and chairs, is demonstrated by the successful experiment of the Great Western railway; and the *rationale* of such a mode, and its peculiar adaptation to the circumstances of Ireland, in spite of the abundant stone of that country, are well exhibited by Mr. Vignoles, in the appendix to the Irish railway report, (appendix A, No. 1.) The rigidity and the vis inertiæ of stone supports, indeed, may be held to be one among the many causes in operation which induce such a fearfully rapid wear and tear upon some of the existing railways.

"The comparative saving in the mere superstructure of wooden and iron railways may be thus tabularly exhibited:

Wooden Rail.			*Iron Rail.*		
5280 cubic feet, 2*s*. per ft.,	528	0	With rails 60 lbs. to the yard		
Paynizing,	62	8	it will cost for rails, chairs,		
Wedges, labor and carriage,	300	0	bolts, etc.,	2400	0
Contingencies,	240	0	Labor and carriage,	300	0
3520 sleepers, at 3*s*. 6*d*.,	616	0	Contingencies,	240	0
	£1746	8	3520 sleepers, at 3*s*. 6*d*.	616	0
				£3556	0

Balance in favor of wood in superstructure alone, £1809 12*s*.

"Besides this, there will be at least one-fourth less cutting, and a continuous saving in wear and tear of machinery, carriages, etc., which may be two-thirds less in weight, with equal tractive power. But the immense saving in construction, in superstructure, earthworks, embankments, masonry and purchase of land, is even of less importance than the immense moral and social advantage which the system involves, of connecting towns and villages in all directions, which the present mode altogether excludes from the benefits of more rapid intercommunication. On the present system, a saving in the expense of embankments, necessarily involves an additional cost of working. A better illustration of this cannot be found than in a comparison of the two surveys of Sir John Macneill, in his valuable report on the North Irish line (report, appendix, No. 4.) There are scarcely any gradients or curves in the Irish railway report, which need be avoided by the guide wheel system of wooden railways. By such a system, a line from Shrewsbury through Wales, to Port Dynllaen, even more direct than that suggested by the commissioners, might, in the first place, be thus constructed for less than one million sterling, bringing Dublin within 12 hours of London; and thereafter the Irish metropolis might be brought into rapid communication with every town in Ireland, at an average cost of £4000, or £5000 per mile."

"To sum up the benefits to be anticipated from the adoption of the new system.

"First, as regards the details of expenditure:

"Tunnels, deep cuttings, embankments, and bridges will, in most cases, be entirely obviated, seeing that gradients of 1 in 20, and curves of 500 ft. radius, may be readily surmounted at a speed of 25 or 30 miles per hour: the purchase of land is reduced in amount; the material is greatly cheaper than iron: engines and carriages may be reduced to one-third of the usual weight, with greater tractive power; the annual wear and tear is also reduced, and as the rails are laid down on the existing face of the country, no disfigurement of the ground is necessary upon private estates, which are ordinarily deteriorated to an extent for which no amount of compensation can be an adequate equivalent; and, at the same time, as a necessary consequence, the crossings from one part of an estate to another may be maintained in every direction. It is to be noted particularly that the system involves no central rail, or indeed any complexity to preclude its adoption on existing iron railways.

"Second, as regards the public interest:

"Safety is insured by the use of the guide-wheels, which, being adapted to the upper and inner edge of the rail, and attached at an angle of 45 degrees, preclude the possibility of an overturn, while, by their peculiar construction, scarcely coming into play except when a great centrifugal influence arises, there is no calculable amount of abrasive action on the tram.

"Cheapness of transit to all classes, is of course induced by the redu-

tion of primary expenditure; and ease and comfort are in an eminent degree secured by the avoidance of those causes of oscillation which are involved in the use of the conical tire on the iron system.

[We do not pledge ourselves to the absolute correctness of the statistics of the above plan, but we thought the subject of so interesting a nature as to warrant us in laying it before our readers.]

"An experiment to test the adaptation of the guide-wheels to iron railways has just been made upon the Hayle line, and has completely succeeded. The groove of the guide-wheels was reduced so as to pass over the chairs in which the iron rails are fixed. A loaded truck fitted with guide-wheels, and divested of the flanges on the bearing wheels, was propelled with a fourth less power than one equally laden, but with the common flange-wheels; proving that an engine can take a train of carriages fitted with the Prosser wheels one-fourth heavier than with the flange-wheels now in use. Moreover, the oscillation, when going at full speed, was found to be almost insensible. This will produce a corresponding saving in the wear and tear of carriages and engines, as well as add greatly to the duration of the rails; and the adoption of the guide-wheels to existing or projected iron railways is worth the attention of those engineers who are unwilling to adopt the wooden rail till it has been fully tested by practice on the lines that have determined to make use of it."—*English paper.*

HARRISBURG AND LANCASTER RAILROAD.

We have the report of this company dated September 6, 1844, giving a detailed account of the state of their affairs. We extract the following statement of the business and cost of working the road. It will be seen that the repairs of the track laid with the heavy rail were only $68·38 per mile, an amount unprecedentedly low, but of which no explanation is given.

"The whole revenue of the fiscal year is as follows:

From passengers, - - - -	$53,639 40	
" freight, - - - - -	18,667 17	
" mails, - - - - -	5,400 00	
" rents, - - - - - -	170 12	
" sale of old materials, - -	123 01	—$78,891 36

"The expenses proper of the road and company may be condensed from the statements of the treasurer and superintendent, as follows, viz:

1. Maintenance of way and expenses of real estate and fixtures,	$8,094 47
2. Locomotive power, - - - - - -	15,165 88
3. Cars, - - - - - - - -	3,562 42
4. Carrying mails to post offices, removing snow from track, damages for killing cattle, - - - -	579 28
5. Insurance, taxes, attorneys' fees and legal expenses,	466 46
6. Salaries of superintendent, clerk, collectors and conductors,	2,731 68
7. Salaries of president and secretary, and travelling expenses of board and officers, - - - - - -	2,163 94
8. Office rent, office expenses, postages, - - -	406 07
9. Printing, stationery, engraving bonds and sundries, -	369 54
	$33,527 96

"The interest upon the company's debts, if they were all funded, would be per annum, - - - - - - $35,200 00

"The miles travelled by passengers are 1,446,316, being equivalent to 40,147 through passengers.

The revenue from passengers is \$53,639 40, equal to \$1·34 on an average for each through passenger, or $3\frac{71}{100}$ cents per mile.

"The number of passenger and baggage carried over the road, (reduced to four wheeled cars) is 5820, equal to 209,520 miles, and the average number of passengers to four wheels, is 6·79.

The whole eastward freight in lbs., is - - -	23,219,021
The whole westward freight in lbs., is - - -	12,268,944
Total eastward and westward, - - -	35,487,965
The eastward tolls amounted to, - - - - -	\$9,944 79
The westward tolls amounted to, - - -	8,122 38
Total eastward and westward, - - - -	\$18,067 17

Red. to 4 wheel cars.

The number of freight cars cleared, is - - -	9,003
The miles run by freight cars are, - - -	259,291
The equivalent number of through cars, - - -	7,203
The average load per car in lbs., - - -	3,942
The average receipt per car in dollars, - - -	\$2 01
The average receipt for each through car, - -	2 51
The average receipt for each mile run by freight cars, $6\frac{27}{100}$ cents,	

"The maintenance of way and expenses of real estate and fixtures have cost $11\frac{12}{100}$ cents for each mile run by locomotive engines.

"The locomotive power, which includes repairs of engines and tenders; fuel for locomotives and machine shops; oil, cotton waste and rags; wages of enginemen and firemen; wages of laborers engaged in pumping water for engines, tending switches, sawing wood, watching bridges and depots, amounts to $20\frac{24}{100}$ cents per mile, run by locomotives.

"The whole expenses proper of the road and company, amount to $46\frac{22}{100}$ cents per mile run by locomotives, almost exactly the same as last year.

"The expenses of the passenger and baggage cars have been unusually heavy; the stock having been greatly improved in condition during the past year. The distance run by our cars has been increased 50 per cent. in consequence of the arrangements with the Eagle line; it is equal to 313,590 miles run by 4 wheeled cars. This item, exclusive of oil, which is found by the Eagle line, costs $1\frac{12}{100}$ cents for each mile run by 4 wheels.

"The greatest distance run by one engine, is by the Charles B.

Penrose, being in miles, - - - - - -	19,836
The least distance is by the Flying Dutchman, - - -	2,664
The whole distance run by all the engines, - - - -	72,432

"This is divided as follows, viz:

Engines without cars, - - - - - -	1,060
Passenger trains exclusively, - - - -	33,606
Freight trains exclusively, - - - - -	18,192
Mixed trains, carrying freight and passengers, - -	18,864
Trains carrying road materials, - - - -	600
Total, - - - - - - - -	72,432

"The average cost per mile of the repairs of 18 miles of iron track, between Dillerville and Elizabethtown, including roadway, bridges, and superstructure, labor and materials, is - - - - \$663 38

"The average cost per mile of the repairs of 18 miles of flat bar track, between Elizabethtown and Harrisburg, including roadway, bridges and superstructure, labor and materials, is - - - \$359 24

"It appears from this that the repairs of the plate rail track cost per mile more than five times as much as those of the track laid with the H

rail; without taking into consideration the wear and tear of engines and cars, the loss of time and the reduced loads which can be transported over the former. These items amount in the aggregate to vastly more than the interest on the cost of a good track on the remaining half of the road. The board look forward confidently to the early construction of this important improvement, which will enable the company to increase their freight business very materially, and will add greatly to the comfort and convenience of travellers. We do not now press its consideration, because we deem all matters of minor importance to the great measures which we have so much at heart, and which we again earnestly urge upon the stockholders, viz. the funding or redemption of the floating debt, and the cancellation of the assignment. When these obstacles are removed, the construction of a new track between Elizabethtown and Harrisburg will be of easy accomplishment, and will follow as a matter of course.

EDWARD MILLER, *President.*

We give also, the statement of the numerous items included in the expenses of the year as per account of the superintendent.

1. Repairs of 18 miles of track, between Dillerville and Elizabethtown, including roadway, bridges and superstructure, labor and materials,	$1,230 80
2. Repairs of 18 miles wooden track, between Elizabethtown and Harrisburg, including above items,	6,412 33
3. Repairs and improvements of depots, machine shops, warehouses, water stations and weigh scales,	451 34
4. Repairs of locomotive engines and tenders,	5,276 56
5. Repairs of passenger and baggage cars,	3,562 42
6. Wood—fuel for locomotives,	2,874 23
7. Coal—fuel for stationary engine and machine shops,	390 96
8. Oil, cotton waste and rags,	913 11
9. Wages of enginemen and firemen,	3,286 25
10. Wages of laborers engaged in pumping water, tending switches, sawing wood, and watchmen,	2,415 77
11. Carrying mails to post offices,	490 03
12. Removing snow from track,	61 70
13. Insurance on Harrisburg property,	93 76
14. Attorney's fees and legal expenses,	131 98
15. Printing and stationery,	90 86
16. Salary of superintendent,	900 00
17. D. Lapsley, trustee, hire of engines and cars,	1,800 00
18. Old debts—incurred prior to assignment,	157 63
19. Damages for killing cattle,	27 55
20. Taxes,	239 76
21. Salaries of collectors, conductors and clerk,	1,821 58
22. Sundries,	17 12
23. Balance of check rolls of prior year,	556 05
Total disbursements, etc.	$33,209 77

Corresponding with trustees' statement.

BALTIMORE AND OHIO RAILROAD.

We have the eighteenth annual report of this company. It commences with the affairs of the "main stem," then follows the Branch to Washington, and thirdly it discusses the difficulties to be overcome in carrying the

road to the Ohio river. It is accompanied by important tables and in an appendix are given the answers of the company to questions put by the legislature as to the lowest rates of transportation during the last winter, and which were published at that time in the *Journal.*

The two first parts will be given entire or nearly so in our next number as no remarks of ours could do justice to them, but as the continuation of the line to the Ohio necessarily involves much local detail of routes of little interest to the profession generally, we give a few extracts.

"The board have to regret that the obstacles which, since 1842, have retarded the further extension of the railroad continue to operate; and have prevented any efficient progress in the actual prosecution of the work, beyond Cumberland, towards the Ohio river.

"The board continue to regard the extension of the road to that point, as the paramount object not only of their duty, but of the authorities of the State and city, and of those public spirited individuals by whom the enterprize was originally projected, and has been subsequently fostered. They cannot doubt that it will be so regarded by all who desire the ultimate prosperity of the city of Baltimore, the welfare of the State at large, or the preservation of the large amount of capital which has already been expended.

Although upon a just interpretation of the various acts constituting the Maryland charter, the right of the company to extend the road within this State, may still exist; and although it is quite feasable to extend it to the Ohio river, without using any more of the territory of this State, the extension could not be made without further permission, from the State of Virginia, or that of Pennsylvania; and, even in Maryland some additional modifications of the charter might be desirable.

The original charter by *Pennsylvania,* as early as 1828, required as a condition of the grant, in case the railroad should not terminate on the Ohio river in the vicinity of Pittsburg, that the company should, at the same time, construct a lateral road so as to connect that city with the main line. The time allowed by this act expired in the year 1838, and although in the year 1839 the legislature renewed the grant, it did so upon new conditions in favor of the Pennsylvania trade, which, after full investigation, it was deemed inexpedient to accept. Nor is it probable that these restrictions will be relaxed, unless the company would consent to abandon any other point on the Ohio river, and to terminate the road at the city of Pittsburg; *or at Brownsville on the Monongahela river.*

The charter by the State of Virginia, passed in 1827, granted, within that State, most of the privileges conferred by the Maryland law; and allowed the road to strike the Ohio river at any point not lower than the Little Kenhawa; but, in a subsequent act, passed in April 1838, renewing the grant for a longer period, the company was required to construct the railroad to the city of *Wheeling.* This law also authorized a subscription by the State of *Virginia* to the stock of the company of one million of dollars and a like sum by the city of *Wheeling.*

"Until recently, the construction of the road from Cumberland to Wheeling, without using part of the territory of Pennsylvania, was deemed, by those supposed to be best acquainted with the subject, altogether impracticable; and it is not unreasonable to conclude that this impression, after the act of Virginia of 1838, limiting the termination of the road to Wheeling, had a material influence in imposing the onerous conditions of the Pennsylvania law, passed in the following year.

"The act of the State of Virginia of April 1838, also contained a limitation in point of time, and contemplated the completion of the road on or before the 4th of July 1843.

"The stockholders are already acquainted with the obstacles arising out of the condition of the money concerns of the country, and the consequent derangement in business of all kinds, which rendered it absolutely impossible to finish the road, at least without numerous sacrifices, within the period mentioned in the Virginia law.

"It has therefore become necessary, prior to any resumption of the work, to obtain from the State of Virginia some further time, within which the board may be enabled to use the privileges granted by the charter of 1827.

"Under those circumstances, the board directed their attention to the advantage of a more southern termination of the road, than that contemplated by the Virginia act of 1838.

"Accordingly, in the summer of 1843, they directed a particular reconnoisance, by the chief engineer, of the country between the Potomac and Ohio rivers, at various points upon the latter between Wheeling and Parkersburg, in order to ascertain the facilities of extending the railroad through Maryland and Virginia, and through Virginia alone, without touching Pennsylvania: and also to ascertain the most practicable and advantageous connections with the trade of the State of Ohio, and, through it, of the Western States in general.

"The general result of the reconnoisance has satisfactorily shown the practicability of constructing the railroad through the States of Maryland and Virginia, without passing into Pennsylvania, or through the State of Virginia alone, (avoiding both Pennsylvania and Maryland,) by various advantageous routes from several points on the Potomac at and west of the Soth Branch, to sundry points upon the Ohio river, between Wheeling and the mouth of the Little Kenhawa.

"All the routes embraced by this reconnoisance, through Maryland and Virginia have three principal terminating points upon the Ohio river, namely: the mouth of Fishing creek, the mouth of Middle Island creek, and the mouth of Little Kenhawa at Parkersburg.

"By extending the road along the Ohio river, any other intermediate point within the above range, such as *Sisterville* and *Marietta*, might, if desirable, be made the terminus.

"These routes might commence either at Cumberland, or at the crossing of the north branch of the Potomac, six miles below." * * *

"It has been observed that the chief object of the introduction of railways was the transit of merchandize: and, although in the course of their operations it has become apparent that passenger travelling will be the business of greatest value, the original design has lost none of its positive importance. On the contrary, the successful application of locomotive power, to the transportation of merchandize and heavy burthen, has satisfactorily shown the adaptation of proper lines of railways to all the purposes of commerce. Recent improvements in the construction of the ways; in the locomotive power and in the cars and other machinery; greater economy in the cost of transportation, added to the steadiness and uniformity of their operations in all seasons of the year, and to the increased velocity easily maintained without injury to the way, have satisfactorily shown, both in the United States and in Europe, that railways, particularly those of great length, may be profitably employed as thoroughfares both for passengers and burthen. On both sides of the Atlantic they are universally used for both purposes, and are to a great extent becoming preferred lines of communication.

"Within the last twelve years little if any capital has been employed in the construction of canals, either in this country or in Europe, except perhaps, where necessary to avoid obstructions in navigating rivers, or to unite navigable waters for the purposes of a continuous navigation; while during the last twenty years, in constructing and perfecting a system of railways, an expenditure has been incurred, equal to, if not exceeding the cost of all the canals existing in both countries.

"In England, railways have been long in use, in connection with the most extensive collieries; and as a part of the works of the Delaware and Hudson coal company in New York, a railway is employed with decided advantage for the transportation of their heavy burthen."

We are sorry to be able to show the board in error in one of their positions: "within the last twelve years" the State of New York has spent 20 millions on canals and, adding the sums spent in that time in Ohio, Indiana, Illinois, Pennsylvania, Maryland, Virginia and Canada on canals also, we shall have a total expenditure of fifty millions, worse than thrown into the Atlantic—spent on monuments of folly and corruption. This large sum has been laid out in the most efficient way conceivable to prevent the undertaking of other works—it is in fact an anti-improvement fund of the most formidable character. To it we are indebted for the wretched restrictions imposed on the people of this State, who are not only subject to a direct tax of $700,000 per annum to support the canals and meet their liabilities, but are also debarred from the use of railways for the transportation of freight. For the pitiful act of last winter allowing them to carry freight during the suspension of navigation, but paying canal tolls, is little better than an insult to the community. But little better is the conduct of the legislatures of New Jersey and Maryland in taxing passengers on railways. The Baltimore and Ohio company are unable to reduce their rates of fare between Baltimore and Washington because the State receives 20 per cent. of the fare, and the consequence is that numerous lines of stages are in successful operation and great numbers of passengers are induced to take the steamboats of the Chesapeake. Fancy for a moment a tax of 20 per cent—say 0 cents—on each passenger travelling on the Hudson!

For a long time the great difficulty was to raise the means for carrying the railway to the westward; now the obstacles which oppose its progress are those raised by the legislatures of the States of Virginia, Pennsylvania and Maryland.

A careful perusal of these reports will convince most persons, that all we require in this country, to secure the construction of all really useful communications is to be "let alone."

BOSTON AND ITS RAILROADS.

Who that has visited Boston and witnessed the enterprize of its inhabitants, the public spirit of its men of business, and the rapid increase of its public works, does not see the giant strides with which it is overhauling its proud sisters, New York and Philadelphia? Though by no means the first city to embark in the construction of railroads for the purpose of open-

ing a more rapid and easy communication with the interior and distant parts of the country, yet she is now by far the best accommodated with these time and *money-saving machines*, of any city in the Union. There are at this time no less than six distinct railroads, radiating from Boston into five different States; and several of these roads have branches to important manufacturing town or shipping ports, whose centre of business is Boston. There is at this time near twelve hundred miles of *connected* railroads terminating in Boston; and they are still extending the main lines, and increasing the number of branches, in various directions, to other important towns, so as to *insure* a steady, rapid and permanent increase of the business and therefore of the population and wealth of Boston.

We were delighted when attending the convention of citizens of Massachusetts, Vermont and New Hampshire, at the Tremont Temple in September last, to observe the spirit of the Boston capitalists in relation to the extension of the Fitchburg railroad northward to Vermont and Canada; and especially with the noble liberality of the president of that convention, who said that "on reading the report of the Engineer" who surveyed the route from Fitchburg to Brattleboro', "he felt it to be *his duty* to the the business men of Boston, to subscribe *ten thousand* dollars towards building the road." Who ever heard a New York capitalist speak of promoting public works as "*a duty* to the business men" of New York? Echo answers, who?

The best—the *true* spirit pervaded the Boston merchants on that occasion, and *fifty* men were appointed to present subscription papers to the merchants and business men for their quota of the $1,000,000 to complete the capital required to build the road to Brattleboro'; and of their success in obtaining it in due time there was not a reasonable doubt, notwithstanding about $1,-500,000, had already been subscribed in Boston since January last, to other railroads, branching from those already constructed and terminating in Boston. It is true that, in thus opening their numerous avenues into the interior and to distant parts, they are promoting their own permanent interest by the rapid increase of business, and consequently the value of real estate; and therefore it may be said that they are entitled to no credit for their liberality—that may possibly be so—yet they are entitled to much credit and we wish we could say the same of the citizens of New York—for their *sagacity* in making the discovery—and of profiting by it.

EASTERN RAILROAD.

This road consists of three distinct corporations; one in Massachusetts, one in New Hampshire and one in Maine. Its entire length is 105 miles, and its cost $3,788,218 17.

The management of the whole line being in one company, or rather two companies, having the same man, D. A. Neal, Esq., of Salem, for president of each, there is no jarring of interest, but all things appear to be well managed. They divided 6½ per cent. in 1843, and judging from what we saw and learned in passing over it, and from the monthly reports of business

this year to 1st July, the net profits will exceed 8 per cent. The number of tickets sold per day is about 1500 and the average price less than 55 cents each which shows that a very large part of the travel is *Way* travel. During the past winter several thousand cords of wood were brought over this road from Maine to Boston at $2 a cord, thus demonstrating in a convincing manner the value of railroads, not only to large cities but also to those who have anything to send to market—even wood.

The machinery and cars on this road are of a superior order and the conductors attentive and affable. The road is in tolerably good condition; the rail is of the T pattern, supported by cast iron chairs of peculiar construction, being much higher than those in general use, designed to aid in keeping the track free from snow.

When this road was commenced, the majority of the inhabitants of Salem doubted its being a good investment of capital, and some even proposed, as we were informed, after it was fairly commenced, to abandon it. Yet now, notwithstanding a rival road, the Boston and Maine road, through Andover, Dover and Exeter to Portland, or to North Berwick where it unites with this road, it is esteemed a good investment, and the people are actually talking of another railroad from Salem to Boston, intermediate between this and the north road through Andover; thus showing in the most conclusive manner that railroads above all other modes of communication, create their own business.

An effort will soon be, if it has not already been made, to extend this road on to Brunswick and Bangor, thereby opening a more easy communication between Boston and the interior of Maine. This is a measure certain to be carried into effect, and at an early day.

The following extract from the report of the directors in July last, will show the estimation in which the stock is held by those who know its value.

"To meet the increased and increasing traffic, six new merchandize cars have been put on the road, and one of the heavy engines so altered as to be better adapted to the rails, and a part of the cost has been carried to construction account. A new engine of great power has recently been received and is now on trial, and a new passenger car will shortly be placed on the track, the bill of which, about $6,500, when paid, will be carried to the same account, and will it is believed be all the additional working apparatus that is required for our present business.

"The 1950 new shares held by the company, as per last years report, were disposed of shortly after the annual meeting, at par."

BOSTON AND MAINE RAILROAD.

This road embodies more distinct interests than almost any other road of equal length. The distance from Boston to Portland by this route is 109 miles and there are no less than *five* corporations embraced in it; 1st the Lowell road is used for 15 miles; then that part in Massachusetts, reaching to the New Hampshire line; then that part in New Hampshire; then the line in Maine from New Hampshire to South Berwick, where it unites with the Portsmouth, Saco and Portland road, on which the cars run thirty-three

miles. This road passes through an excellent country, filled with flourishing villages most of which have grown up within a few years by means of their manufactures. They divided six per cent. last year and the net income will probably exceed 7 per cent. this year. The prosperous condition of this company has induced them to construct about 20 miles of new road from Boston to a point on their present road near Ballardville and thus become independent of the Lowell road, to whom they now pay for the use of 15 miles of their road. When this extension shall have been completed, as it will be early next year, there will be *six* distinct lines radiating from Boston reaching into adjoining States. The termination of this road with an extensive depot, is to be nearer the centre of the city (within 1000 feet of State street) than either of the others. The general management of this road appears to be good, the cars are easy and neat, but there is occasionally delay at the junction, as there will often be, where two roads rely upon the same power to perform a part of the service.

The superstructure is laid as follows:

"The earth excavations, and embankments are levelled off, and one and a half feet of sand, or gravel, is then filled on to the road; the subsills of plank are then laid longitudinally, and the sleepers of chestnut, cedar or hackmetac are laid transversely, partly two and one half feet, and partly three feet apart. Iron rails of the T pattern are then laid, supported at the joints by cast iron chairs, and spiked to the sleepers; sand or gravel is then filled in between the sleepers."

The averrge width of grade is 14 feet, and the greatest curvature 1050 feet radius.

This and the "Eastern railroad" through Salem and Portsmouth, may be considered rival lines, yet the managers of both appear to be actuated by a desire to accommodate the people, and at the same time benefit their stockholders, rather than to destroy each other, and they have therefore entered into an amicable arrangement by which the fares on the two roads are uniform.

LOWELL RAILROAD.

This is, we believe, justly considered one of the best built and most productive railroads in the country. We passed over it a short time since and found it in excellent condition and well managed. This was the first railroad built in this country parallel with a canal, and now the canal is scarcely thought of, although it is still in use, as we inferred from what we saw. The business of Lowell must be greatly facilitated by this road, as must be that of other manufacturing towns by its continuation—the Nashua and Concord road; and it appears singular to those at a distance that the people of New Hampshire will stand so much in their own light as to prevent its extension across the State to some point on the Connecticut river from whence it may be extended to Burlington Vt., or to Canada; but so it is, and they, like the people of this city will be compelled to do in self-defence what they should have done as a matter of policy, before others got the start of them;

and then the Lowell railroad will reap the rich harvest, to which, by its favorable position it is entitled.

We were disappointed in not obtaining documents which would enable us to speak definitely in relation to its current business as compared with previous years; but from what we learned it is safe to anticipate a greater dividend than was paid last year, which was 8 per cent.

HARLEM RAILROAD.

This road was opened on Saturday last, 26th inst., to White Plains Westchester county, the distance of about 27 miles from the City Hall. The president, directors and invited guests of the company left the City Hall a few minutes past 1 P. M., and reached the terminus of the road, near the village of White Plains a little after 3. The route of the road is for several miles along the valley of the Bronx, crossing it five times in seven miles. So far as we could judge the new part of the road is substantially built and he rail of good pattern and well laid. From the statement of the president we learn that they have now ample power both of horse and steam, with a ull supply of good cars, to work the road efficiently, which we hope will e done both for the benefit of the stockholders and the convenience of the ommunity.

Soon after our arrival at the terminus of the road, all were invited to take eats at the tables, which were under the charge of chief engineer *Downing*, nd of course well supplied with *steam*. The president of the company, *David Banks*, Esq., took the chair, and was supported on his right by the hancellor of the State, and on his left by the vice chancellor, with several nembers of the judiciary and of the common council of this city on either ide, who appeared to take a deep interest in the important business of the ay, and to enjoy in prospect the benefits to result from the extension of the oad to that point. The president made a lengthy statement in relation to e present condition of the company and alluded to the probable connection ith the Housatonic railroad and to the possible extension to Albany *direct*, ut he did not, nor did any other gentleman who spoke, take the broad round which we have long contended for, that there must, *will* and SHALL e a railroad directly to Albany and above all to *lake Erie*; and that it is ot only the interest but also the *duty* of the capitalists, owners of real este and the business men of New York, to come forward at once and subcribe for the stock; and we were somewhat disappointed in not hearing ese important topics discussed by some of the able and deeply interested iends of railroads who were toasted and responded to the compliment.

Many toasts were given and speeches made, complimentary to the genemen who now have the management of the work, and we hope they may t only feel encouraged, but also in duty bound to adopt *immediate* meares to extend the work to Albany. It is now more than *eleven* years nce the Harlem railroad was commenced, during which time the city of oston has constructed or contributed mainly to the construction of nearly

five hundred miles of railroad, by which she reaches directly *five* different States, and shares with New York the benefit of her great canals and the immense trade of the great west. It is not, then, we trust, expecting too much of those who have given new impetus to the works on the Harlem railroad, when we say to them, gentlemen the *people* of New York look to you and others of like enterprize, for the extension of this work, and not only this but one of still greater importance; so that we may, when our noble rivers are in icy fetters bound, penetrate the interior. Shall they be disappointed?

A more favorable period could not perhaps be desired than the present for the resumption of operations on these two important roads. There are now in almost every direction, long lines of railroad successfully engaged in the transportation of freight as well as passengers; and it is no longer a doubtful question of their ability to compete successfully with canals for heavy freight. It has also become matter of history that railroads create business for themselves; and that when judiciously located between important points, and especially through a productive agricultural and manufacturing region, they not only contribute largely to the business facilities of the people and particularly to the *poor*, with whom *time* is capital, but also insure to those who own the stock a liberal, and what is better, a constantly increasing return. Rivers increase in volume as they receive the successive tributaries which flow into them, and are of course important or insignificant in proportion as their course is extended and through a region affording abundant streams. So with railroads between important points, and through fertile regions, abounding in the elements of a varied and extensive business and terminating in large cities, they become useful to the people and profitable to their owners in proportion to their length and the number of branches and latteral roads, which are sure to connect with them from year to year, when once in operation. Then it is that those links in the long chain of road, which are nearest to its principal termination, become the most important and most profitable. Why not, then, gentlemen of the Harlem railroad, make *your* road the last link in those important chains which are sure to reach, not only Albany and lake Erie, but also the *Canadas* and the great *far off west?* These and nothing *but these* are terminations worthy of the efforts of the *city of New York!*

READING RAILROAD.

Since our last number the second track of this road has been completed, and we have to regret our inability to be present at the celebration of its opening in accordance with a polite invitation to be there. It matters little, however; the day was auspicious, the company large and merry, and the performance all that, and even more than the most sanguine friends of railroads had claimed for locomotive power. We only wish that the whole city of New York, or at least *every business man* of it, could have been there to see the "*Ontario*" locomotive, with its 150 iron cars, containing

764 *tons of coal*, or a quantity sufficient to load the largest packet that ever sailed out of this port previous to the introduction of locomotive engines into the United States—moving on at the rate of 8 or 10 miles an hour—towards the Delaware. What would the *British army* have said if, while they were revelling in the luxuries of winter quarters in a large city, and WASHINGTON and his brave Continentals were freezing and starving at Valley Forge, they had discovered the approach of such a power with such followers? There would have been, it strikes us, more swearing than there ever was in Flanders; and *possibly* the sight of such a performance might have aroused the good citizens of New York to the performance of their duty and to the construction of *the great work* which is to add so much to the *wealth*, the *comfort* and the *reputation* of their city.

IMPROVED RAILROAD CAR TRUCK FRAMES.

We observed at the Fair, in Boston, a model of an improved *truck frame* for railroad cars, which we ascertained was from the manufactory of Messrs. *Davenport and Bridges* of Cambridgeport. The peculiar advantages of this plan are its simplicity and durability. The entire frame is of wrought iron and it is put together and firmly secured by only *eight* bolts, instead of over sixty, as in most wooden frames; and what is also important, it is both *lighter* and *cheaper* than the wooden frame, and when by any accident it shall be broken, the fragments are still good wrought iron, and worth half as much as when new, and in the bar. On visiting the manufactory of these gentlemen we found that in other respects, as well as that above alluded to, their cars are of a superior quality and worthy of the examination of railroad companies wishing to purchase substantial cars.

BRATTLEBORO' RAILROAD.

We learn by the Boston papers that $920,000 of the million required to complete the railroad from Fitchburg, Mass. to Brattleboro', Vt. has been taken in Boston since the convention in September last. This is as we anticipated from the spirit evinced by the Bostonians at that meeting, and increases the amount subscribed in Boston to railroad stocks since January last, to nearly $2,500,000.

☞ The Baltimore and Ohio railroad company have lately reduced the freight for the transportation of flour from Cumberland to Baltimore from *sixty* cents to *fifty* cents a barrel, and from Harper's Ferry to Baltimore to *twenty-five* cents.

The following notice leads to the supposition that the old projected line across the centre of Vermont is to be again brought into the field.

"Notice is hereby given that the books for subscription to the capital stock of the Vermont Central Railroad, will be opened on the 29th day of this month, at 1 o'clock, P. M., at M. Cottrill's in Montpelier, and at Howard's hotel in Burlington.—*October 12th*, 1844."

PROSPECTUS *for an* ENLARGED RAILROAD JOURNAL.

☞ After the 1st of January next, this Journal will be issued weekly, in quarto form, of 16 pages, as from 1832 to 1838. The quantity of matter given will be three times that of the present Journal, and the price will be increased from two, to three dollars, *in advance.*

The immense amount of capital expended on railways in this country; the great number of new works projected, and sure to be undertaken before long; the actual value of railways as permanent investments and the general interest taken in them by the public, demand at least a weekly Journal devoted mainly to the dissemination of railway information. In England there are at this time *four* such Journals, exclusive of the scientific works. There, however, the openness with which all is carried on, and the interest taken at their frequent meetings by the *stockholders* who are not directors, furnishes an immense quantity of matter for the railway press. Occasional extracts from the discussions at these meetings will be of use here in stirring up the individual stockholders to a knowledge of their rights. Our limited space as well as the sphere of our discussions for the last few years has kept our circulation almost entirely among Engineers; but we now propose, without rendering it less useful or interesting to them, to add much valuable information wanted by a new and very large class of readers whom we hope to reach.

The object of our journal, when first established, was rather to collect information which might be useful to those embarking in, or having the superintendence of, such novel undertakings; as at that time there were only 92 miles on five different railways in operation, and locomotive engines were scarcely known in this country. Then details of construction occupied the prominent place; whereas now, the *management* of railways, their *cost, income* and *dividends,* will especially receive our notice; though all improvements, whether actual or projected, will of course continue to receive our unremitting attention. We now intend to bring out a weekly paper which shall not only be useful to the Engineer, but we hope indispensable to that large portion of the community who look to railways as offering a safe, permanent and productive investment of capital; or, we may say more briefly, that we aim at a Railway Journal for *stockholders,* and those taking a general interest in the progress of railways and other public works, as well as for Engineers who have the superintendence of construction and the management of railroads.

We shall publish in each number carefully corrected tables, showing the statistics of the various railroads both in this country and in Europe, together with accurate reports of the weekly sales of stocks; and we shall speak freely in relation to the management of railroads as we may from time to time feel called upon.

We design also to make it useful for advertising Railway, Steamboat, Canal and other means of travel and transportation, as well as for the manufacturers of Locomotive Engines, Cars and all other Machinery.

AMERICAN

RAILROAD JOURNAL,

AND

MECHANICS' MAGAZINE.

Published Monthly at 23 Chambers-st. New York, at $2 a-year, in advance, or 3 copies for $5. | D. K. MINOR, Editor.

No. 12, Vol. 2 Third Series. | DECEMBER, 1844. | Whole No. 443. Vol. XVII.

THE RAILROAD JOURNAL.

☞ This number closes the volume and the *thirteenth* year since the commencement of its publication.

Of the wonderful improvements made within that period, both in the construction and management of railroads, it is quite unnecessary now to speak except so far as it may be useful by way of illustrating the future. It is enough, to say that the system has grown within that time both in this country and in Europe, from less than *one hundred* miles in either, to *several thousands* in *each* country; and that the onward progress of the system never was as rapid, as certain nor as successful as at the present time.

Believing that a well conducted periodical, devoted mainly to the cause, will promote its success, we announced in our last number that the *Railroad Journal* would, on and after 1st of January next, be issued weekly in its original quarto form of 16 pages.

It seems to us highly necessary that shareholders should become more familiar with their particular roads, as well as with the operation of the system generally, both in this country and in Europe. This can only be done by a more frequent publication of this or some other journal devoted to the subject.

Having been the first to establish a periodical of the kind either on this or the other side of the Atlantic, and entertaining the opinion that railroads are destined with very few exceptions to supersede canals as well for transportation as for travel, and that important improvements are yet to be made both in their construction and management, we are resolved to devote our efforts to the advancement of this important cause, which is doing so much to promote the prosperity, comfort and intelligence of the millions—the mass—*the poor!*

We hold that railroads are doing more than any other institution among us except our schools, towards placing the people on terms of equality, and fortunately their tendency is to level *upward*, instead of downward. They

enable the poor man to ride as comfortably as the rich, and what is of the utmost importance to them they save more than the cost in *time*.

Entertaining these views of the value of railroads and of the advantages which may result to them and we hope to ourselves from a well conducted journal devoted mainly to the cause, we do not hesitate to adopt the plan herein indicated, and confidently rely for support on those of our citizens, whose interests are more or less identified with the success of railroads.

BALTIMORE AND OHIO RAILROAD.

In giving the report of this company, as promised in our last, we would draw attention to two important points towards the establishment of which the Baltimore and Ohio company have contributed so largely. These are firstly, the very large amount of business which a railway through a thinly settled country will draw to itself, and secondly, the views presented as to the actual cost of transportation on works with the gradients and curves of the Baltimore and Ohio railway. Both positions are again confirmed by the experience of the Western railroad of Massachusetts.

It seems necessary for us to give the following report for other reasons. We shall be obliged frequently to refer to it during the coming winter in discussing the proper policy to be pursued in this State, and especially in pointing out the causes which have so long delayed the re-commencement of operations on our greatest undertakings.

At a meeting of the stockholders held pursuant to the charter, on the 2nd Monday of October 1844, in the city of Baltimore, the president and directors of the Baltimore and Ohio railroad company submitted the following report and statement of the affairs of the company:

First.—Of the Main Stem.

The statement A shows that the state of the company's affairs on the 30th ultimo; and the revenue and expenses of the *main stem*, for the year ending on the same day, are shown by the statement B.

There is also submitted a tabular statement, marked C, prepared by the engineer of machinery and repairs, which presents in detail the operations of the main stem, and the actual expenses of working that part of the road during the year; together with the amount of receipts, from all sources, during the same period.

These statements show a considerable increase both of travel and trade: and a diminution in the expenses, in proportion to the amount of business: and it is worthy of remark that, although the number of passengers over the entire length of the road, has increased at least thirty-six per cent. upon that of the past year, the aggregate increased cost of transporting them does not exceed five hundred dollars.

It is believed that the economy in the working and management of the road, is as perfect as that of any other similar road in this country or in Europe.

The revenue received from passengers, is greater by $59,712.21, and that from tonnage $22,061.32 than the receipts from the same sources during the preceding year; making together $81,773.53.

The net receipts from the business of the main stem, over and above the expenses, independent of its connection with the Washington branch, amount to the sum of $346,946.03, being nearly five per cent. upon the capital, and

one per cent. more than the net earnings of the year ending on the 30th of September, 1843.

The injuries to three of the culverts near Harper's Ferry, alluded to in the last annual report, have been fully repaired, and the work finished in the most substantial manner, at a cost of $1,500 less than the estimate presented in that report.

The board regret that, in the present report, they are called to record an accident to the bridge over the Potomac at Harper's Ferry, by which one of the arches of that structure has been destroyed.

The arch gave way under the weight of a single Engine and tender, after sustaining the entire work of the road for nearly two and a half years, and, only the day previous, eight heavy trains of passengers and burthen, without the slightest indication of defect or weakness in any part.

Providentially, no life was lost, and but slight injury sustained by any of the men who were carried down in the fall; nor was the engine materially damaged.

A delay of a few hours only was occasioned in the passenger travel, and the interruption in the tonnage transportation was less than a week.

The remaining six arches of the bridge, even those contiguous to that which fell, have received no injury from the fall.

A thorough investigation into all the particulars of the accident, has satisfied the board that it was occasioned by the decay of several pieces of timber, comprising an important part of the framing of the arch.

This part of the superstructure, in order to protect it as far as practicable from the weather, had been closely covered by weather boarding and roofing, which rendered it inaccessible to the ordinary inspection constantly made of these structures; and the timber having been in use for two years only, there was no reason to suspect any unsoundness.

No settlement of the frame had previously taken place inconsistent with the soundness and safety of the structure, and it had borne, only the evening previous, the usual trials of its strength; indeed the final fracture took place in a part of the frame so situated, and so surrounded and kept in place, as that there could be no sensible yielding without a total giving away. The decay, therefore, most probably proceeding from an unperceived leak in the tin roof and the spreading of the water between the several pieces of timber composing the straining beam, had been progressing silently and unsuspected, until the strength of the remaining sound wood became insufficient to withstand the strain to which it was subjected.

This accident, it is believed, does not authorize any suspicion of an inherent defect in the principle of construction of this, or any other bridge employed on the line of the road. In the opinion of the skilful engineers, by whom the plan of the bridges was adopted, it is a combination of the most excellent and approved forms of superstructure known to the science of engineering: the principal features being modeled after those of the celebrated bridge over the Rhine at Schaff haausen, which, previously to its destruction by fire, was considered one of the most admirable specimens of the art in the world. The heavy trade of the railroad, and of numerous droves of cattle on that part of it common to the public, which the ruined arch had withstood for more than two years, and the greater evidence of strength offered by some other bridges precisely the same in principle on other parts of the line, for upwards of five years, also inspire great confidence in the plan of these structures; which, from the lesson now learned, may be renderad even more secure in the future.

Immediately after the occurrence of the accident, the weather boarding

was removed from all the other structures upon the line of the road, and a minute investigation made into the state and condition of all their parts.

Every precaution will be immediately taken to give additional strength and security to these structures; and nothing will be omitted to prevent a recurrence of an accident.

The board have already determined upon a plan of reconstructing the arch at Harper's Ferry, which will not only ensure more adequate protection of the timber from the effects of the weather, but, at the same time, expose all parts of the structure to a daily and minute investigation of their condition.

The entire loss occasioned by the accident, and the sum required to restore the arch to a condition of even greater strength and security, is estimated not to exceed $7,594.40, being $8,932.92 less than the surplus revenue of the year just ended.

In all other respects the entire line of the road, including the depots and water stations; together with the cars, engines and machinery of every description, are in a state of thorough repair, and adequate, without augmentation, for the accommodation of twelve per cent. more than the business of the past year.

During the year there have been paid to the Messrs. Baring an instalment of $50,000, and interest to the amount of $14,809.72, amounting, with the cost of placing the funds in England, to $71,106.92, and the former being paid in advance produced a saving in interest of $1,100. After these payments the balance due Messrs. Baring, payable in annual instalments of $50,000, is reduced to $200,000.

In the same time there has been paid from the receipts of the year, for an additional engine mentioned in the last annual report; for walling the shafts of the Doe Gully Tunnel, keying up and refitting bridges; for the sideling at Dam No. 6, under the arrangement with the canal company; for improvements at the Cumberland depot, balances for right of way, and various other items arising out of the construction of the road, the sum of $46,747.45.

There have also been paid in the year $29,200 of the debts remaining unpaid, alluded to in the last annual report; leaving of this class unsettled only $11,500, which is yet in litigation.

Besides the foregoing items, there have been applied during the year $38,216.74 to the construction of coal cars for the transportation of coal from the mines to Baltimore, pursuant to the contract with the Maryland and New York iron and coal company, referred to in another part of this report: and which, during the present year, the board propose to reimburse from the proceeds of the coal trade.

After these payments, and the payment of interest on account of the million loan, the net revenue of the year from the main stem, (including the sum of $61,956 received from the Washington road,) amounts to $200,582.18, and with $10,945.14, the surplus of the year 1843, makes an aggregate of revenue on hand from this road, of $211,527.32.

Of this, the board have applied to the purposes of the sinking fund, according to the resolution announced in the annual report of 1842, for the reimbursement of the loan contracted for the construction of the Washington road, the sum of $20,000, and of the balance, they have determined to divide among the stockholders, two dollars and fifty cents upon each share of stock, payable on and after the first day of November next; leaving a surplus of $16,527.32; being $8,932.92 more than the cost estimated to repair the loss occasioned by the accident to the bridge at Harper's Ferry.

While reporting the condition of the main stem, and result of the opera-

tions of the year, the board would not discharge their duty if they failed to recall the attention of the stockholders, and especially that of the city authorities, to the onerous expenditure annually incurred by the necessity of introducing passengers and burthen into the city by the employment of horse power, and which must necessarily subtract that sum, whatever it may be, from the amount which might otherwise be divided among the stockholders, and paid into the city treasury. This source of expense, already amounting annually to no less than $18,171.77, must continue to increase in proportion to the augmentation of trade and travel over the road.

Considering the numerous sources of competition with which, in its present unfinished condition, this work so essential to the prosperity of the city, must contend, every motive of sound policy would seem to recommend the utmost possible reduction in the expenses of transportation; and if Baltimore hopes successfully to contend with other rival works, in whatever quarter they may exist, the public authorities will find it necessary to lend all the aid in their power to cheapen the introduction of produce and merchandize into this market.

The necessity of employing horse power through the streets of the city, does not add less than ten cents per ton to transportation of all kinds upon the railroad; of which the obvious effect is not only to drive much of the trade to other channels, but to reduce the net revenue upon that which it may be possible to retain.

The harmless employment of steam power under proper regulations in the streets of other cities, and, by another company, in those of Baltimore, already shows that the privilege may be extended to this company without serious apprehension of damage; and it may be safely affirmed that if the city authorities desire to retain the present amount of trade in flour and other produce; or to enjoy to any considerable extent the advantages of the transportation of coal, this privilege will be indispensable.

In the last annual report, the stockholders were informed that, upon the application of the Chesapeake and Ohio canal company, the board has consented, with their existing power, and as a part of the general trade, to engage in the transportation of coal from Cumberland to dam No. 6 on the canal, at two cents per ton per mile, to be thence carried by canal to the District of Columbia; and it was at the same time stated that, the company might engage in it at a less charge on the whole or any part of the line.

It will appear in the course of this report, and has already been officially stated to the legislature, that it may do so at little more than half that charge.

The charge of two cents per ton per mile had been previously established as the fixed rate for the transportation of coal, without regard to time, distance or quantity; and the object of the canal company, in proposing the arrangement, was to induce this company to provide the necessary sidelings at dam No. 6, and engage in the transportation, in connection with the canal, at the same rates.

If in the opinion of the canal company a less charge than two cents per ton per mile would have been necessary for the success of the arrangement it desired to make, it would have been practicable to make an arrangement for that purpose; and if the railroad company could have relied upon an amount of trade equal to 50,000 tons per annum, it would have been willing to have increased its machinery for that purpose, according to the growth and requirements of the coal trade.

The canal company proposed the charge of two cents as a rate mutually for the interest of both companies; and, in the opinion of those proposing it, as low as would be necessary to insure the transportation of coal upon the

railroad to dam No. 6, in sufficient quantities "to meet the growing demand in the market for that article."

Representing the toll on coal by the canal from dam No. 6 to Georgetown, at half a cent per ton per mile, and the freight at the same, the president of the canal company believed that two cents per ton per mile on the railroad, even during a period of two years, "would enable the dealer to sell his in market at a profit sufficient to encourage the trade."

The means of transportation at these rates being insured, the extent of the demand would, nevertheless, in the opinion of the canal company, be uncertain, and the trade necessarily in some degree, an experiment, only to be determined by circumstances: though from assurances received from parties concerned in the coal fields, the quantity of iron and coal which one company alone would require to be transported the first year, it was thought would amount to from fifty to eighty thousand tons: that "a regular supply being furnished the principal steamboat company on the Hudson would consume about $500,000 worth annually, and that the consumption of the city of New York alone, would not be less than 200,000 tons per annum."

The canal company rightly judged that, if the coal fields of the Allegheny could be developed to such an extent, or even in a far less degree, the arrangement proposed would be mutually advantageous to both companies; and although this company was in no degree misled by these expectations, and were satisfied that many years would elapse before they could be realized even to a moderate extent, they were unwilling to reject an appeal thus made, and decline a business upon terms which, under any circumstances, and without reference either to amount or regularity, would yield a good profit.

The result however has proved that the canal company either greatly overrated the ability of the coal dealers, or the extent of the demand; since from that time to the 30th ultimo inclusive, notwithstanding this company provided a sideling at dam No. 6, costing $2,000,—less than 4,000 tons of coal, and not any iron, has been offered for transportation in the manner contemplated by the arrangement. It may be added that, during the same period, no evidence was afforded that any capital had been obtained for working the mines, or any arrangements made towards the preparation of the necessary transportation of coal from thence to Cumberland; except in the instance of a single company; and by that, arrangements have been made with the railroad company for the transportation annually, for the period of five years, of fifty thousand tons of iron, coal and fire brick, from the mines to Baltimore.

Under such circumstances the board deemed it inexpedient to make any addition to their existing power, or to adopt the improved machinery by which it is now certain the cost of transportation, may be, and in fact has been reduced to little more than half the charge assented to between Cumberland and dam No. 6.

Until the board could be certain of completing the railroad to Cumberland, there was little occasion to investigate its capacity for the transportation of coal; and indeed from the character of the machinery generally in use upon railroads before that period, a general impression prevailed that for heavy articles, the value of which in market bore so small a proportion to their weight as to admit of very low charges, for long distances, these roads would not be a desirable mode of transportation.

For, although a like weight of flour and coal, other things being equal, might be transported at the same charge, it is nevertheless obvious that in consequence of the greater value of a ton of flour than an equal quantity of

coals, a rate of charge which might well be paid by the former, would be altogether too high for the latter.

The improvements in railway machinery, however, have been gradually, but constantly, progressive; and in the spring of 1842, when it was certain that in the course of the year the railroad would be completed to Cumberland; anticipating that, from that time they might be required to some extent to engage in the transportation of coal, at least for the consumption of Baltimore, the board directed a thorough investigation by Mr. Knight, chief engineer, into the power of their machinery for the purposes of transportation generally, including that of coals and iron.

For the better understanding of what follows, it may be proper here to state that, the chief, if not the only object for which railways were first introduced, was the transit of heavy merchandize at a moderate rate of speed; and, for many years after their introduction, were exclusively used for the purposes of the great colliery railways in England. As late as the year 1821, the first of the modern or travelling class was autherized in England: and in 1826 the railway between Manchester and Liverpool was chartered. Down to that time the transportation of heavy merchandize was the chief object it professed; and even then it was not determined to employ locomotive power. As late as the year 1829 when it became necessary to determine the nature of the power to be employed, the utmost capacity hoped to be attained in the locomotive was an engine weighing not more than six tons, capable of drawing on a level and straight road, at ten miles an hour, three times its own weight, and to cost less than $3,000. Although at least one eminent engineer in England ventured, at that time, to hazard the speculation that at some future day an improved engine might be constructed with capacity to maintain a speed of twelve, sixteen, eighteen or twenty miles an hour, it was treated in the official reports of commissioners selected to determine the nature of the power, as so extravagant as to prejudice the scheme of employing the use of locomotive power.

Long before the spring of 1842, this speculation had been more than realized.

The genius of American artists also had outstripped the improvements in England; and this company was actually employing upon their road engines weighing fourteen tons, running on eight wheels, of which four were drivers; and capable of drawing on a level and straight road 500 tons, and over grades of eighty-two and a half feet, with curves of one thousand feet radius, not less than eighty tons at a speed of eight miles an hour.

The investigation made by Mr. Knight, under the direction of the board, contemplated the use of this class of engines. So far as it related to coals, it also contemplated a regular trade, which, in his estimate, he charged with a full share of the expenses of maintenance of way, and interest of six per cent. upon the capital. Including these elements, he estimated the cost of the transportation of coals from Cumberland to Baltimore at one cent and a half per ton per mile. Comprehending the same elements, the cost would have been less from Cumberland to dam No. 6.

The report of Mr. Knight was submitted and published in March, 1842; and as early as that period, Ross Winans, an ingenious mechanic of Baltimore, had not only contrived a far more important improvement in the locomotive, but had actually constructed an engine weighing twenty tons, running on eight wheels, all of which are drivers,—and with the weight equally distributed over the whole, so as that the bearing upon any one is not greater than upon that of the ordinary machine of ten tons weight,—capable of hauling over a level and straight road, 1100 tons; and over grades of

eighty-two-and a half feet to the mile, with curvatures of one thousand feet radius, about 170 tons, at a speed of eight miles per hour.

With a knowledge of the results of Mr. Knight's investigation and of the further improvements and advantages in railway machinery, it was impossible the board should doubt their ability to engage in the transportation of coals, at rates not only profitable, but sufficiently low, according to any rate of charges then known, to exclude the apprehension of rivalry from other quar ers. In this sense only are the observations of the board upon this part of the subject, in their second reply to the house of delegates, when confined to their context, to be appropriately taken.

The capacity of the railway for the transportation of coals was accordingly announced in their annual report of October 1842; and it was at the same time assumed that, when the road should be completed to Cumberland, and thence to the mines, the demand in the market of Baltimore, and other parts of the Union, might, in a short time, require the transportation of 100,000 tons of coal annually.

The board was satisfied that without suitable conveyances from the mines to Cumberland, neither the coal nor iron could be advantageously sent to market from Cumberland, by any channel whatever; and, in the meantime, they deemed it inexpedient to make any preparations to engage in the business. They considered it not less apparent that even after such conveyances should be provided, the trade in coals, would be regulated by the extent of a demand, in a great degree dependent upon the price at which the article could be afforded.

Neither point was free from embarrassment, and the interest of the stockholders required that the subject should be investigated with great care. The grounds upon which a just determination could be made were in some degree speculative. So far as any positive data could be obtained, the consumption of bituminous coal had been gradually and regularly diminishing, and that of the anthracite increasing in a much larger proportion, and, within some years past, with great rapidity. The latter had been advantageously adapted to the manufacture of iron: more extensively to the use of steamboats, locomotive engines, to the purposes of manufactures generally, and for all domestic uses. The consumption of this article had been gradually extending throughout most parts of the Union. From the facilities of delivering it in the market by the Delaware and Hudson work, the Reading railroad and other improvements in Pennsylvania, the price had been gradually diminishing, and the low price at which it was ordinarily selling in the markets of Philadelphia and New York, made it quite plain that the existing demand for coals, for most purposes throughout the country, was fully supplied by it.

It was, therefore, obvious that the introduction of the Cumberland coal, in any considerable quantity, could only be effected by superseding, to nearly an equal extent, the use of the anthracite; and from the preference so long given to the latter, and the adaptation of machinery of all kinds to its use, they believed the degree in which this might be effected for many years at least, exceedingly doubtful; too doubtful, in their opinion, to warrant a large expenditure of capital in preparations for the trade. It was desired rather that the extent of demand should be previously tested by actual experiment.

If any reliance could be placed upon the estimates of the cost of transportation upon canals by the improved Ericsson propellers, it was evident that, with suitable roads from the mines to Cumberland, and the use of the railroad to dam No. 6, even at the rate of two cents per ton per mile, the expe-

riment might be made with nearly the same advantage as when that work should be completed to Cumberland.

In that case, the charge for transportation upon forty-five miles of railroad, at two cents per ton per mile would amount to ninety cents: the tolls one hundred and thirty-four and a third miles of canal at half a cent per ton per mile for the cargo, and two cents per mile for the boat, (assuming the average cargo of boats to be eighty tons) would be seventy-four cents: and if to this should be added thirty-three and a half cents for transportation on one hundred and thirty-four and a half miles of canal, at the rate of forty-six cents for one hundred and eighty-four and a half miles, and thirty-five cents for contingencies and transhipment at Georgetown, making together sixty-eight and a half cents, the entire cost of transportation by this mode, of a ton of coal from Cumberland to Georgetown, including expense of putting it on board a vessel at that place, would not exceeed two dollars thirty-two and a half cents.

If the charge upon the railroad should be placed at one and a third cent per ton per mile, as it might be, the entire cost of coals, according to the assumed cost of the Ericsson propellers, from Cumberland to Georgetown, would be only two dollars two and a half cents per ton.

Without meaning to vouch for the results expected from the application of the Ericsson propellers, no reason was perceived why they might not be used with the same advantage, below as above dam No. 6; and that if a demand for the Cumberland coal could, under any circumstances, be created to any extent, it might not be effected as well in the manner here mentioned, as by any other means.

It appeared to be the plain duty of the board, therefore, to await such developments; and, to engage in the business when it should be demanded by the public, and be profitable to the company.

In the month of January 1844, and previously to the order of the house of delegates of the 24th of that month, the board were officially informed by the president of the Maryland and New York iron and coal company, that having procured the funds requisite to construct a railway from the mines to Cumberland, he was anxious to proceed with the work; if the charge for the transportation of iron and coal from the mines to Baltimore, could be fixed at such rate as would warrant him in adopting the Baltimore and Ohio railroad for the transportation of his products.

The same officer subsequently proposd a contract for that purpose, to continue for five years after the completion of his road; to furnish a freight of coal, pig iron, bar iron, fire brick and castings and other manufactures of iron, (the principal freight being coal) in quantities of one hundred and seventy-five tons per day, for three hundred days in the year. The construction of the railway from the mines to Cumberland, was represented as dependent upon the acceptance of the proposition by the railroad company, upon terms which would be entirely satisfactory.

After the necessary investigation of the subject, the board agreed to furnish cars and moving power, and to transport the freight proposed from the mines to a suitable shipping point at Baltimore, at the rate of one cent and one third of a cent per ton per mile, a distance of one hundred and eighty-eight miles, with an addition of ten cents per ton for transportation through the streets of Baltimore; the cars to be loaded and unloaded at the expense of the Maryland and New York company, and when iron and other articles should be transported in house cars, there should be added for such articles one cent per ton per mile for one hundred and eighty-eight miles.

These terms were accepted by the Maryland and New York company,

who proceeded to the construction of the railway, and to make the other requisite preparations to carry it into effect.

This company also is preparing the proper number of the heavy engines, and coal cars; and both parties have mutually agreed that the operations under the contract shall commence on the first day of November next.

The estimates of cost upon which the board felt warranted to enter, into this contract, will be found in the appendix to this report.

In the course of a short time, therefore, any speculation which may in any quarter be indulged of the ability of either party to comply with its engagements, will be at an end: and the adaptation of the railroad to the transportation of coals and iron at the above rates will be subjected to the test of actual experience.

On the 25th of January, and February, 1844, respectively, during the negotiations with the Maryland and New York iron and coal company, and without the prompting or knowledge of the board, two orders passed the house of delegates, requiring the president and directors to report to the house the lowest rate of toll per ton per mile, at which the company would agree to transport coal, iron, etc., from Cumberland to dam No. 6, under a permanent arrangement; and also to report upon various other points comprehended in the orders.

These orders and the several replies of the board to the points embraced in them, dated the first and fifteenth of February, will be found in the appendix to this report; and will afford, it is believed, a satisfactory view of the whole subject.

If by the inquiries contained in the orders, the legislature designed, as it may be presumed they did, to invite or lead the railroad company to lend its assistance to the encouragement or development of the coal trade, the terms upon which the board expressed their willingness to do so must be conceded, in any view of the subject to be just and reasonable.

The rates of charge, stated in the replies, were little more than one half of those that had been previously proposed as quite low enough to develope the trade; and, sufficiently low, in the mode indicated in this report, to enable the dealer to put his coal on board of a vessel at Georgetown, and thence at New York at less cost, it was supposed, than coal from other parts of the Union had been previously delivered at the same city.

Indeed, the rate of charge assented to by the railroad company appeared to be so much lower than had been anticipated, and so much below what had been previously deemed sufficient, as to beget an apprehension of the ability of the company to engage in the trade at such rates.

The other terms presented in the replies of the board cannot be deemed less reasonable. They required only, previous to expending the capital of the stockholders in making preparations for the trade, that communications absolutely indispensable to the transportation of coal to market should be made from the mines to Cumberland; that capital should be provided to work the mines, and that responsible parties should engage to furnish coal in proper quantities, to employ the machinery necessary for its transportation.

These conditions were considered as the appropriate evidence of the existence of a demand to an extent, short of which, no means of transportation would be needed.

The coal and iron of the Allegheny region is not to be developed by a demand dependent upon a precarious and occasional supply. On the contrary, it can only be effected by steady operations, conducted with such capital as will be adequate to maintain a regular trade; and if those concerned

in such operations have no confidence in a demand equal to the sale of fifty thousand tons per annum, there can be little inducement for the preparation of extensive conveyances to market. The board at least was unwilling to expend one or two hundred thousand dollars in machinery, not adapted to other purposes, for a branch of transportation dependent upon casualties by which it might be only occasionally employed: and unless they would have been content to rely upon vague expectation, and a precarious trade, it is difficult to imagine any conditions more reasonable than those prescribed.

That the estimates of the cost of transportation are sufficiently liberal, there need be no reasonable doubt.

Founded by the actual experience of the company in their operations, they are little liable to error; and are sustained not only by the engineers by whom they are prepared, but by Mr. Knight, by whom they have been carefully examined, and compared with the elements of his former report.

That they may be fairly understood, these estimates must be considered in reference to the particular trade to which only they are applicable.

They suppose a distinct branch of transportation separate from, and wholly independent of the general trade and traffic of the road; and therefore not properly chargeable with the existing and fixed expenses incident to the general miscellaneous business; which would be the same without the trade in coals.

They also include only that degree of wear and tear due to this particular operation.

The estimates suppose also: First—the use of the heavy improved engines, possessing double the capacity of those assumed in the former report of Mr. Knight. Second—a cheaper and lighter description of cars, by which the useful load in proportion to the weight of the car is considerably increased; and Third—a larger amount, and greater regularity in the trade.

Conforming the data embraced in the report of Mr. Knight of 1842 to these elements, the present estimates will be shown to be abundantly sufficient. They have also received the approbation of respectable scientific journals throughout the Union, and are found to be even more liberal than those comprehending the actual cost of similar transportation upon other roads in the United States.

All estimates of the actual cost of transportation upon English railways, of which we have any accurate knowledge in detail, are of a date so remote as to embrace only the earlier description of locomotive power; possessing from a third to a fifth of the capacity of that proposed to be employed upon the Baltimore and Ohio railroad in the transportation of coals: and contemplate the use of a description of cars weighing one ton and three-tenths, and with a capacity to carry two tons and six-tenths of coal.

Conforming the actual cost, according to the experience in England, and the description of machinery there employed, to the improved engines and cars to be used by this company, it will be foud to correspond with the present estimates, and to verify them in every particular. By the most recent authority of the best approved authors of England, it has been confidently stated that coals may be transported upon English railways at half penny per ton per mile: which is not only about the same as the cost assumed in the estimates of this company, but, when taken in connection with the more expensive operations of English railways, would warrant even a less estimate in the United States, than that now given.

The board have it in their power to state also, that, subsequent to the date of the estimates submitted to the house of delegates, a further improvement

has been made in the construction of the coal cars, by which a greater reduction in the cost of transportation is effected.

The estimates submitted to the house of delegates adopted a car of a wood frame, costing three hundred and eighty dollars, weighing three tons and carrying seven tons of coal. In the improved car, subsequently invented and now adopted, sheet iron, in a cylindrical form, is substituted for wood, costing three hundred and forty dollars, weighing two and a half tons and carrying seven tons of coal.

In the appendix to this report the board subjoined a revised estimate of cost founded upon this improvement, and including interest of six per cent upon the capital employed in the machinery; by which it satisfactorily appears that coal may be transported from the mines to dam No. 6, at a cost less than one cent per ton per mile; and to Baltimore at a cost of one cent and half a mill per ton per mile.

It is thus shown that the statement of the capacity of the railroad submitted by the board in their reply to the legislature of the 15th of February 1844, is in all respects confirmed, and may be fully relied upon.

The board desire again to repeat that whether it may be expedient to engage to any extent in the transportation of coal at the rates now estimated, must depend upon contingencies not at present to be foreseen. They have at no time particularly desired to engage in it; and would always regard it as quite subordinate to the paramount duty of pressing forward their work to the Ohio river; leaving the general trade in coals and iron from the Allegheny region, to others more ambitious of monopolizing it. So long, however, as the railroad may be arrested at Cumberland, the transportation of these articles must unavoidably form a natural and legitimate object of attention; and during this time, if those concerned in supplying the demand, looking to the advantages of speed and uniformity of working at all seasons, find it advantageous to resort to the railroad, neither the interest of the stockholders nor a due regard to the trade of Baltimore would permit the board to decline the business.

Second.—Of the Washington Road.

The affairs of the Washington road are shewn by the statements D and E.

These statements show an improvement not less gratifying in the trade and travel and in the operations of the road, and also in the expenses of working the road in proportion to the business, that has been already stated in those of the main stem.

The net earnings for the year ending on the 30th ultimo, are $104,519.33, being upwards of six per cent.; which added to the surplus of the preceding year amounting to $6,275.86 make an aggregate of $110,795.19, or six and five-eighths per cent. upon the capital of the road. Of this sum the board have decided to divide among the stockholders six dollars per share, payable on and after the first day of November next; reserving a *surplus* of $11,795.19.

The board deem it proper on this occasion to announce their purpose in future of dividing among the stockholders the net earnings of this road semi-annually, without reference to the operations of the main stem.

The sum paid to the State for the six months from the 1st of July, 1843, to the 1st of January, 1844, being one-fifth of the gross receipts from passengers, amounted to $18,189.19, and from the 1st of January, 1844, to the 1st of July, 1844, to $22,851.10, making together $41,040.29.

It will be observed that if to this sum of $41,040.29 be added the sum of $33,000, the amount of dividend to be received by the State from the Wash-

ington road, $12,600, the dividend from the main stem, and $1,269,60 regularly remitted to London as the interest on £5,250, the amount of the sterling bonds sold on account of the State's subscription of $3,000,000, it will be seen, that during the year, the State has received the aggregate sum of $386,809.89 being nearly nine per cent. upon the actual investment in both roads.

The railway, the passenger and burthen cars and depots and water stations are in good condition; and a comparative statement of the operations upon the road during the past and preceding year, is here appended, marked F.

In the last annual report the board adverted to the rivalry between the inland route south of Washington, by the railroad through Richmond and Petersburg, of which the Washington railroad forms an important connection, and the bay line from Baltimore to Norfolk, and thence by the Portsmouth and Roanoke railroad: and they stated the desire of the parties interested in the southern railroads, that this company should co-operate with them in such reduction in the fare upon the Washington road as might be necessary to bring a greater amount of travel to the inland route.

The board also acquainted the stockholders with the provisions of their charter, forbidding any reduction in the charge upon the Washington road with the consent of the legislature, or, in the recess, of the Governor of the State: and which also prevents the railroad company from applying to the legislature for such consent, without conferring upon that body a dangerous control over the chartered privileges of the company.

During the last session an application was made to the legislature by other parties to consent to a reduction in the charge; and the railroad company itself was desirous that the discretion vested in the Governor to be exercised by him in proper contingencies in the recess, should also be extended to the board of directors, in order that it might be exercised when a proper occasion should arise with a better knowledge of the circumstances than the Governor in most cases could possess.

It is very obvious that at the time of granting the charter, although it established for general purposes a maximum and minimum charge, the legislature itself foresaw that contingencies might arise in which it would be expedient and necessary, temporarily at least, to reduce the charge; and accordingly on this ground they authorized the Governor to act in the recess. Experience has shown that the necessity thus contemplated was not overrated by the legislature; but it has also shown that the discretion they provided for the emergency, has proved altogether inadequate; and under these circumstances it appeared to the board, not less for the interest of the State than for the public and the stockholders, that a similar discretion should be vested in the board, who with a familiar knowledge of the subject, might act in this respect under the same responsibility as that under which all their other duties are performed.

By any existing law, the board have the unlimited power to reduce the charge upon all passengers going and returning between the two cities of Baltimore and Washington, or between any intermediate points on the same day: and no objection was perceived to such enlargement of the power as might be found to increase the travel upon the road, and to augment the revenue of the company.

It pleased the legislature, however, not only to withold such discretion from the board of directors, but to adjourn without giving any consent upon their own part to a reduction in the charge; and it is the opinion of the board that in consequence of this failure on the part of the legislature, many passengers between Baltimore and Washington, and Baltimore and points

south of Washington, and also a considerable number who were desirous of attending public celebrations of various kinds, have been prevented from using the railroad, to the serious injury of the interest of the State and of the company.

After the adjournment of the legislatures, measures were taken by parties more immediately interested in the success of some of the southern railroad companies, to establish an opposition between Baltimore and Washington, which has already diverted a considerable number of passengers from the Washington road.

On the 15th of June last, two lines of stages commenced running for the conveyance of passengers between Baltimore and Washington and intermediate places. On the 25th of August, another line was added, and since that day three lines have been running in each direction daily, by which passengers are conveyed from one city to the other, and taken up and set down at any place in either, at the charge of one dollar and fifty cents each.

By the annual report of the Richmond, Fredericksburg and Potomac railroad company, dated 27th May last, it would appear that these lines have been established under the auspices of that company.

In that report it is stated:

"Large as this increase is the board of directors have no doubt it would have been materially larger, but for the high charges on the southern travel, imposed by the State of Maryland, and the Baltimore and Ohio railroad company on the Baltimore and Washington railroad.

"The excessive rate charged on the through travel on this work, has tended to retain on the bay, and to throw into coasting vessels, or divert over the Baltimore and Ohio railroad to the Ohio river, a considerable amount of travel which would otherwise have been secured to the line of railroad and steamboat communication through Virginia.

"The presidents of the Virginia railroad companies having for years remonstrated with the directors of the Baltimore and Ohio railroad company, and lately appealed to the governor and legislature of Maryland unsuccessfully, on the unfairness of exacting an undue proportion of the charge which could be judiciously made on through passengers, the attention of the board of directors has lately been directed to other means of preventing for the future the injury which has hitherto resulted to them from this cause, and they are sanguine, that by means of an efficient line of stages, which will be placed about the 15th proximo, on the Baltimore and Washington turnpike, and which in connection with the railroad and steamboat companies will convey passengers between Baltimore and Richmond, and points south of Richmond, at much lower rates than heretofore, they will be able to recover a large portion of the travel which has hitherto been diverted from their route by the charge on the Baltimore and Washington railroad.

"Should their expectations in this respect be realized they will be enabled to protect themselves against the competition of other routes, at the same time that they will prevent the reduction in their charge, (which will be confined to passengers taking the stage line,) from benefiting the Baltimore and Washington railroad, and thereby tending to keep up the excessive charge which has hitherto been levied on through travel on that work.

"Should the legislature of Virginia co-operate, as the board of directors can scarcely doubt they will, by refusing a right of way, or any other privileges to the Baltimore and Ohio railroad company, until they shall have redressed the grievance of which the State of Virginia, and the Virginia railroad companies have so much reason to complain—the board of directors entertain no doubt it will be ere long corrected."

It is understood from other sources, although not official, that the Richmond, Fredericksburg and Potomac railroad company, has contracted to pay the stage proprietors two dollars and fifty cents upon each through passenger carried by the stages between Washington and Baltimore, in either direction, in connection with the lines south of Washington; and has also stipulated to pay the stage proprietors five thousand dollars, if the stages are withdrawn from the route at the company's instance.

From these documents it is obvious that the stages have been established in competition with the railroad, for the avowed purpose of coercing, not the railroad company, for it has no power to act in the premises, but, the authorities of Maryland to engage in a rivalry between different works in another State; in behalf of enterprises comparatively of recent origin, and undertaken with a full knowledge of the declared policy of the State, and of the positive provisions of the law which it is now sought to change.

It is not to be denied that the Washington road is a Baltimore enterprize, designed to connect that city with the metropolis of the Union, and to be supported by the travel to the seat of the federal government from the north, east and west, and from Maryland and her capitol.

As a thoroughfare of southern travel, at the date of the charter, the work was scarcely thought of, for at that time none of the present Virginia railways, forming its southern extension, were projected: and at this day, nearly fourteen years after the origin of the work, the local or Washington travel is the primary, and the through or southern travel the secondary, in the most ample sense of the terms.

It is evident from the report already quoted, that it is no part of the object of the southern companies to reduce the charge upon the Washington railroad, in favor of the public generally: on the contrary, they expressly propose that the reduction should be made in favor of "through passengers" only, or those travelling in connection with the southern lines; and that, this object being attained, they would be content with even a higher charge upon passengers travelling between Washington and Baltimore or intermediate points: a system which, it is understood, the Fredericksburg, Richmond and Potomac company has adopted upon its own road.

If the terms of the contract already referred to, be correctly reported, in the prosecution of their designs and as indispensable to their success, "the Richmond, Fredericksburg and Potomac company" does not in fact derive any greater proportion of the charge for passengers passing over their line, than if conveyed by the railroad, at the established charge; but, on the contrary, consents to sacrifice, or give to the owners of the stages a bonus of one dollar upon each passenger carried in the stages, in connection with the southern lines; and also to incur a penalty of five thousand dollars whenever it may determine to discontinue the cumpulsory means at present employed.

Independently of this sacrifice, it may be well expected that the southern company will ultimately suffer greater injury from these proceedings, than can now be foreseen.

It is not unreasonable to suppose that the substitution, in connection with its route of forty miles of stages, instead of an easy and comfortable railroad, will increase the advantages already complained of in favor of the bay rival: and the consequences most to be apprehended from this novel scheme will be the diversion of a greater amount of travel from the inland to the bay route, and of the local travel between the cities of Washington and Baltimore from the railroad to the stages; such in fact, it is believed, is the result up to this time.

It is obvious, however, that whether the passengers be diverted to the bay line or to the stages, the injurious effect upon the business of the Washington railroad, will be the same.

The number of passengers conveyed by the lines of stages the entire distance between Baltimore and Washington in both directions, from the 15th of June to the 30th of September inclusive, was 3419, and in addition 889 passengers with through tickets to and from points south of Washington, making an aggregate of 4308.

During the same period the number of passengers transported in the trains from Baltimore to Washington at the established rates of the road was 5676, and from Washington to Baltimore 7486, and in addition 2749 passengers with through tickets to and from points south of Washington.

On the 8th of July last, pursuant to the authority conferred by the 7th section of the act of 1836, ch. 261, the board of directors of this company reduced the charge to passengers on the railroad between the cities of Washington and Baltimore, going and returning the same day, to the sum of two dollars and fifty cents for the round trip; and at the meeting on the 4th of September, they established the same rate of charge for similar travel from all intermediate points.

Within this period the number of passengers transported over the railroad with tickets for the round trip, at the reduced rates, has amounted to 2322.

It will be obvious, however, from an examination of the facts and statements now communicated that, unless the stages be withdrawn altogether a reduction of the railroad charges upon "through passengers" only, or those to and from points south of Washington, according to the views of the southern companies, would not prevent the competition, but that it would be necessary to reduce the charge at the same time upon all passengers, passing over the railroad.

By two several communications from the president of the company, dated the 4th of September, and the 4th instant, the governor was made acquainted in detail with all the facts herein stated, and to which, up to this time, no answer has been received.

By these communications the duty of the board has been fully discharged; since having no power of themselves to act further in the premises, the subject, in the recess of the legislature, can only be submitted to the governor to be dealt with as he may deem most expedient.

To the Editor of the American Railroad Journal and Mechanics' Magazine.

SIR:—Although I am not the proprietor of a single share of any railroad, canal or steamboat company, I am not an indifferent observer of the improvement and prosperity of these several institutions of wealth and industry; and to the fullest extent they can be made subservient to the public welfare, I wish them a hearty *God-speed.* And as a particularly satisfactory indication of their growing interest in the public mind, I have noticed the proposal you make to enlarge the pages and contents of your Journal, a work which I esteem as among the most honorable and useful to the present and coming generations, that emanate from our national press.

As I have not the entire series of your Journal, (as I hope by and by to possess,) I may be mistaken in the impression, that neither in its pages, nor elsewhere, does there exist anything like a comprehensive table of the statistics of the different railroads in our country, such as would be almost in-

valuable to the engineer, the broker, the political essayist, and to the statesman, in both State and National legislatures. At the patent office in Washington I was both astonished and ashamed of the niggardly provision which exists even in the library of that great national department not merely of government, but of national inventive genius. A few only of the latest parts of your Journal are to be found there, and scarcely an *entire* series of any other scientific and statistical publication of our country! For one, I trust another session of congress will not expire, without placing an entire series of your Journal and a complete one of every other practical periodical connected with the arts and public improvements, whether published in our own country or in Europe, upon the book shelves of the patent office.

But in respect to your Journal, I think another suggestion is due. It is a publication that is *sui generis* in this country, devoted exclusively to the great spirit and the great works of enterprize and internal improvements in our land; and it ought to be in the hand of every agent, engineer, contractor and director upon these works. If any man of responsible trust connected with any of our roads is not your patron I should esteem him too far behind the age, or too decidedly wanting in spirit and ambition in his pursuit, to merit his station. The public safety—the whole travelling public are interested in the wide diffusion of practical and professional knowledge respecting railroads and especially the diffusion of it among all persons officially connected with their care and management. It carries in it both the preventives and the remedies of accidents and cheapens though silently and unseen, the whole system of transportation, while it elevates the standard of employment and gives new character to the entire business of the operative.

But I have elaborated into an article what I only started to make into a congratulatory letter. Whoever begins to think on the utility of your Journal, cannot well avoid wishing it in the hands of every man connected with the construction and management of railroads, steamboats and canals in our country. Such at least is the sincere feeling of your friend and obedient servant and constant reader, FRANCIS O. J. SMITH.

FOREST HOUSE, *Westbrook Me., Nov.* 18, 1844.

Report of the directors of the New York and Erie railroad company to the stockholders, 17th October, 1844.

The directors of the N. Y. and E. railroad company believing that they have as far as has been in their power, carried into execution the views set forth in their acceptance of office, feel themselves called on, as well in reference to the manner in which they have fulfilled the trust reposed in them as to the results which have attended their measures, to submit at the close of their term of office a brief summary of their proceedings.

It will be recollected by the stockholders, that the critical situation of the company, prior to the election of 1843, had induced them to place the control of that election in the hands of a few gentlemen possessing the confidence alike of the community and the stockholders. It was represented

that the main object of the measure was to ascertain whether the embarrassments of the company could be so far relieved as to enable an entirely new direction to submit again to the city and country, the question of the completion of the New York and Erie railroad freed if possible from all other considerations than those of the value of work done, probable cost of completion, the degree of its importance to the city and country, and the facts which would determine the extent of its pecuniary returns.

The consideration that a work of such vast importance and promise, might through their instrumentality be again placed in a position to be successfully prosecuted to completion, induced the individuals subsequently elected directors to consent to aid in the proposed effort to carry these views into execution.

For a statement of the manner in which the board undertook their responsible and difficult duties, and of the measures which were adopted to effect the ends in view, the stockholders are referred to the report addressed to the public and published Feb. 8th, 1843, a copy of which has probably reached every stockholder.

The board then refer to the failure of their various appeals to the public and to a new plan suggested which met with rather more favor.

The paper prepared on this occasion is annexed to this report. Its main features were, that 200 persons should undertake to furnish the capital required of $6,000,000, on condition that priority of dividend at 7 per cent per annum, be secured to the holders of the new stock, and that 14 per cent per annum should be the interest to be paid by the State, in case the State should elect to purchase the road on its completion.

A larger amount has been subscribed on this basis, than on any other, but the subscription has not reached a sum that will justify the hope that by its means the capital can be raised.

It is with extreme pain that the board find themselves under the necessity of presenting this discouraging statement, but they feel that without it, no proper estimate can be formed of their proceedings, nor a correct idea be given of the present situation of the company.

Disappointed in the result of their measures for obtaining capital by private subscription to the stock of the company, the attention of the board was next directed to the resources supposed to be placed at their command, by the act of 1843. By that act the right to issue bonds to the amount of $3,000,000, was to be waived for that object. By means of the bonds so authorized, it was proposed to raise $500,000 for the purpose of extending the road to Port Jarvis, a distance of about 20 miles from the present termination. It was ascertained that the money could probably be raised in the manner proposed, if the act would make the security offered good. That the character of the security might be satisfactorily established the question was submitted to legal counsel, from whom the opinion was received that the waiver of the State lien was made dependent on the completion of the road in seven years from the date of the act, and that so far as that event was uncertain, there would be a corresponding risk to the bond holders. In view of this opinion, it was evident that the bonds could not be sold, and the measure was therefore abandoned.

The stockholders will learn from what has been herein stated, that the board under existing circumstances referring especially to the lien which the State has on the entire property of the company, have no resource on which they can rely as the means of insuring the construction of the road, and complying with the stipulations of the act to the completion of certain

portions in assigned periods. Attention is called to this position, that if it be found to be correct, those who are hereafter intrusted with the management of the interests of the company, may at an early day take the measures which it renders necessary.

The board are of opinion, that unless the State will agree so to amend the act, as to allow the property of the company to be pledged as security for the expenditure of new capital on the extension of the road from place to place as circumstances permit, there is little reason to believe that any efficient measures can be taken at present for the extension and ultimate completion of the road.

On reviewing the measures of which a brief summary has now been presented, the board are aware, that views may be entertained by some of the earnest friends of the road which are entirely opposed to the position taken by the board, that the work should not be resumed on private subscription, unless the means of its completion were fully provided. They are aware that it may be contended that with a subscription of one or two millions the road could have been so far carried forward, that its completion would have been secured, almost as soon as by a full subscription at this time.

It has been already stated that the board believe that a sum sufficiently large to make it judicious to commence the work at all could not have been obtained on the principle alluded to.

The board would now add that their confidence that remunerating dividends would be paid to persons subscribing to the stock, rested solely on the completion of the railroad to lake Erie, and that therefore they could not consistently with their view of responsibility to subscribers to the stock, ask for their subscriptions on a principle that left that event in great uncertainty. The contingency may not be very great, and by some may even be considered small, but it has been deemed by the board of sufficient magnitude to involve a responsibility which they do not feel themselves called on to assume.

The board are gratified on being able to report on the present financial position of the company, and the amount of business done on the road, in highly encouraging language. The report of February presented the situation of the affairs of the company at the time the present directors came into office. The property of the company was in the hands of assignees, and so entirely without resources did the directors find the company, that the funds required to meet the ordinary office expenses, and to carry into effect the measures proposed to remove the embarrassments under which the company was lying prostrate, were only obtained through gratuitous subscriptions of a few friends of the road. The amount so obtained and which has enabled the board so materialy to improve the financial condition of the company, it has given the board great satisfaction to be able to state that they are now in a condition to repay, with thanks in the name of the company, for the aid so timely rendered.

The measures which are described in the report of February, 1843, as being in progress, have since that time been continued and mainly with the success anticipated.

The embarrassments growing out of the indebtedness have at times threatened the interruption of the operations on the road, without the aid of which the claims against the company would be of but little value. But the representatives of the officers of the company have been successful in effecting arrangements which the interests of the company and the creditors equally required.

On the 2d April, 1844, the board of directors adopted a resolution call-

ing for an instalment to be paid on or before the 20th May last, of five dollars a share on all stock of the company, whereon payment already made did not exceed fifteen dollars per share, under the penalty of forfeiture of said stock, and of all previous payments thereon, as provided in the charter of the company. In default of compliance with such call, 4,290 shares were forfeited, upon which payments had been made of $48,296.90.

In the report of Feb. 1844, the net revenue of the 50 miles in use was stated at $46,000, and that sum was taken as the basis of calculation in deducing an estimate of the probable revenue of the entire road from the actual returns of the road in operation.

Since the publication of the report, such has been the increase of business, that, with a very inadequate equipment of cars and engines, the net earnings of the year ending Sept. 30, 1844, has exceeded $58,000, being 25 per cent more than the sum stated above.

The following have been the net earnings for the last three years, and will be seen to present a very encouraging rate of increase.

Net earnings of the railroad for the year ending Sept. 30th	1842,	-	$31,2[illegible]
" " " "	1843,	- -	43,5[illegible]
" " " "	1844,	-	58,6[illegible]

It may be proper to add that the charges for freight and passengers on the New York and Erie railroad, are less than other railroads in the country, probably without exception.

The members of the present board came into office possessing a very limited knowledge of the merits of the project, of connecting the city of New York with lake Erie by a railroad. Their duties subsequently, have made them better acquainted with the grounds on which it is maintained that its completion will be attended by results in the highest degree important to the city and country. The board would again record what on several occasions they have already expressed, their full confidence in the soundness of such views.

This report is signed by Horatio Allen, president, James Brown, vice president, and D. A. Cushman, C. M. Leupp, F. W. Edmonds, S. Brown, Theodore Dehon, P. Spofford, Anson G. Phelps, Matthew Morgan, John C. Green, A. S. Diven, Wm. Maxwell, Elijah Risley, directors.

At the annual election held on the 23d of October, 1844, the following gentlemen were elected directors for the ensuing year, viz: George Griswold, Jacob Little, John C. Green, James Harper, Eleazor Lord, Paul Spofford, Stewart C. Marsh, Henry L. Pierson, Henry Shelden, C. M. Leupp, J. W. Alsop, Silas Brown, Robert L. Crooke, (and Sidney Brooks, who has since declined) of this city, and D. S. Dickinson of Broome County, A. S. Diven of Allegany and Elijah Risley of Chatauque. At an early meeting of the board, the following address was ordered.

Address.—It may be expected that this board should express to the public their views of the undertaking, the progress of which is the object of their appointment.

Happily the merits of this undertaking are universally acknowledged. The lapse of time has but rendered them more evident and unquestionable: and the importance, not to say the necessity of the work to this metropolis, has come to be very generally felt. But in common with many other public works, including those of this State, its progress has been suspended, and the plans and measures heretofore proposed for obtaining funds for its completion have failed of success.

There is, nevertheless, in the community, not only a prevalent feeling in

avor of this work, but a belief that it may be, ought to be and will be completed—that further delay is neither necessary nor expedient—and that a practicable plan for its resumption and accomplishment may be proposed, and would be promptly supported.

Much of the doubt and discouragement which has heretofore prevailed has arisen from want of information on the part of those who were favorably disposed towards it; but more, by far, from the opposition and misrepresentations of parties interested to defeat it, and from individuals who were disappointed of success in their private schemes. The object of this opposition was to destroy confidence and defeat the undertaking. It proceeded from hostility to the work itself, which was viewed as in conflict with certain local interests, and as prospectively in rivalship with the more northern route to the lakes, which had been rendered populous and powerful by a munificent outlay of the public funds.

The effect of the misrepresentations so long and so industriously propagated, aided as they were by the embarrassments attending and following the suspension of the work, has been to induce extensively an impression that there must be some great difficulty, some formidable obstacle, deeply seated in the scheme itself, or in the manner in which its affairs have been conducted. The failure of the company to obtain the means necessary to a resumption of the work, appears to have strengthened this injurious and unfounded impression. Some elucidation of this subject seems therefore to be called for on the present occasion.

The hostile misrepresentations referred to, had respect chiefly to the prices paid by the company for labor and materials; which were alledged to be exhorbitantly high. Confidence was in this manner impaired and a door opened to every species of injurious imputation.

The facility with which misrepresentation and prejudice on this subject were propagated, was greatly augmented by the disastrous state of the times, and by the madness which seized the minds of a portion of the people, who from being the friends and promoters, proclaimed themselves to be opposed to the construction of public works, whether by corporations or by legislative authority, and seemed to exult in the suspension and ruin of every such undertaking.

Successive legislatures, however, understanding the state of facts in regard to the proceedings of this company, far better than the public did, have passed laws of the most favorable character at nearly every session for the last twelve years; not indeed without the boldest exhibition on the part of some, of the hostility which has been referred to, but generally, nevertheless, by strong majorities. In short, the undertaking and its managers, appear to have had the confidence of the stockholders, of a majority of the legislature, and of that portion of the public generally, who desired the completion of the work.

It therefore seems to the board to be due to the character of the undertaking, to say, emphatically, to those who may be disposed to promote it, that the difficulty in the case is not internal—that it results not from anything in the actual condition or proceedings of the company, but from hostile misrepresentations and false impressions to which it has been subjected. Were this difficulty of a nature to be overcome by testimony, by the results of impartial investigation, or by the opinions of disinterested or candid men, enough would seem to have been done in that way to effect the object; or on the contrary, enough to show conclusively, that while the ruin of the undertaking continues to be considered possible, opposition to it and to all attempts to resume and carry it forward, is to be looked for from the same

source and for the same purpose as heretofore. It can be encountered and surmounted, not by timidity, inaction, and delay, but only by earnest and successful action on some feasible plan.

If therefore the city needs and desires the completion of this work, a timely and resolute effort to sustain and provide for it is imperatively called for; and to such effort, with a right apprehension of the case, and a practicable plan, there is no obstacle, but every encouragement. The public need no further evidence to show that the undertaking is well founded, that its execution is of the highest importance to this city, or that it will, when completed, yield satisfactory returns to its proprietors. The city and the whole country are satisfied in these respects. It remains only to propose and prosecute a plan, which those who desire its completion will not deem impracticable. There is nothing in its condition, its history or its prospects to discourage or impair the value of new subscriptions to the stock. On the contrary if stock in such a work could in any case be deemed desirable or unobjectionable to the citizens of this city, new subscriptions to this are recommended by two unusual and valuable considerations: namely, first that the time necessary for completing the road is brief, compared with that which would be required, were the work now to be originally commenced; and second, that by the law of April 1843, the company are entitled to the State loan of three millions as a bonus, or a return of the monies paid by them, with legal interest, on condition of their accomplishing the construction of a single track of the road within seven years from the passage of that law.

It should be known, however, that by this law, two years only were allowed for the company to resume the work. The period thus limited, will expire in the month of April next, and all the benefits of the law will then be forfeited should the company fail to obtain funds and resume the work before that date.

In the same most encouraging and valuable act of the legislature, provision was made expressly, to supersede the necessity of any very formidable amount of new subscriptions to the capital stock. The company was authorized to issue bonds for three millions of dollars, being half the amount required to complete the work, which were constituted a lien upon the road, in preference to that of the State.

With respect to that law, no renewal of its provisions can be hoped for, should the company fail within the time limited, to avail itself of its advantages, by obtaining funds and resuming the work. Least of all, is any modification of the law for the purpose of authorizing an issue of the whole or a portion of such bonds, as the sole reliance for the means of extending any section of the road, reasonably or with any confidence to be looked for, while no provision is made by new subscriptions for carrying out the entire undertaking. The object and intention of the legislature was to aid, encourage and secure the completion of the entire work. So far as the benefit of the law was intended as a boon to the southern tier of counties, it was intended for all of them; and in so far as the legislature designed in this way to benefit this city, they undoubtedly had in view the entire work, as a thoroughfare of commerce with the lakes and regions of the west. And if with the extraordinary advantages of this law, in a period of commercial prosperity like the present, the means of going on with the work in such a manner as to justify confidence of early and entire success cannot be attained, what rational consideration can be urged to justify any further public patronage? If the importance and the merits of the work will not draw to it the requisite support, who can persuade himself that there is any ground of

hope in the future. If with its acknowledged merits and importance it fails of support from this city, who can bring himself to believe that any further encouragement of it would be conceded by the legislature, or could with any propriety be solicited.

It is known and felt by the friends of this work in every successive legislature, that its benefits are to centre and be realized chiefly in this metropolis, the interests of which in that behalf were so carefully guarded in the charter, by the provisions which confine it within the limits of the State, and contemplate its approaching on the east side of the Hudson, and traversing the whole length of the city. They are also aware, that as yet the city has not been heavily taxed for its construction, the city subscribers having paid less than $400,000; a sum believed to be considerably inferior to that annually saved to the inhabitants, by the reduction in price of a single article of daily consumption, in consequence of the new supplies thrown upon the market from the counties through which the road is in operation —while the inhabitants of the counties on the route have paid an aggregate approaching $1,200,000.

The actual outlay upon this work, including the value of donations for roadway and other purposes, may be reasonably estimated at five millions of dollars: consisting of stock of the company somewhat less than one and a half millions; debts, chiefly settled by obligations at five years, about six hundred thousand dollars; and three millions furnished by the State.

The donations of land furnished for the roadway, depots, stations, and other purposes, are deemed to exceed in value the loss incurred on the sale of State stock, and the damages to unfinished work, consequent on suspension and delay.

Those best acquainted with the subject, with the amount of labor and materials employed, and the prices paid, deem the work to be well worth all that it has cost; and are of opinion, that were it now to be commenced, taking into view the unavoidable loss of time required in such a case, a greater amount or value of results could not be accomplished for a less sum.

Much more than half of the work necessary to prepare the entire line of the road for the rails, has been performed. The work is well done. No part of it requires to be altered. The plan of the work is in no respect inferior to that of any similar undertaking, and is believed to be susceptible of no material improvement. The track is six feet in width, in which respect it is deemed to be more advantageous for so important a thoroughfare, than the narrower tracks on other roads.

Fifty-three miles of the road on the eastern division are in prosperous and profitable operation. On the Delaware, east of Deposit, between 30 and 40 miles are graded. Between Binghamton and the lake, 150 miles are prepared for the superstructure, some of which is laid. The timber for the superstructure is provided for about 250 miles. At the western termination the rails are laid on about ten miles.

To complete the entire line of the road $6,000,000 is deemed necessary and sufficient. Towards this sum, the bonds legally authorized are an eligible and safe reliance for 3,000,000. From a variety of considerations it is believed to be quite safe to rely upon the interior counties for further aid to the amount of 1,000,000. So that to insure the immediate progress and early accomplishment of the entire work a subscription of $2,000,000 only is required. With such a subscription the board would have no hesitation in proceeding with the work in the confidence that no further call upon the citizens of this city will be necessary.

Believing this to be the smallest amount that would give the stockholders

sufficient confidence of success to render their subscriptions safe as an investment, and that subscriptions to this amount will be deemed impracticable or out of proportion for this city, it is proposed to give notice in due form within a few days, comprising substantially the following conditions, viz:

1. That books of subscription to the capital stock will be opened for $2,000,000; the option being reserved by the board of accepting such further subscriptions as may be made prior to the 1st day of April, 1845.

2. That if 2,000,000, and no further sums should be subscribed by that date, the board will rely for subscriptions for 1,000,000 in the interior counties, so as to make an aggregate of 3,000,000, which, with the like amount of bonds, as authorized by the legislature, is deemed sufficient to complete the road from the Hudson to the lake in such time and manner as to secure all the benefits of the law of April, 1843.

3. That an instalment of $5 per share be called at the pleasure of the board after the 1st day of January, 1845, and that subsequent instalments be restricted to $20 per share in 1845; $30 in 1846: and $45 in 1847.

4. That as an equitable, and under existing circumstances, an expedient measure, interest at the rate of six per cent. per annum be allowed on all the instalments on the stock which shall be subscribed, from the dates of the respective payments until the whole line of the road from the Hudson to lake Erie shall be put in operation; and that the same be liquidated and paid yearly on the 1st day of January.

This address is signed Eleazer Lord, president, and dated 31st Oct., 1844.

It will be remarked that the late board do not regard the bonds as offering a reasonable security; Mr. Lord, on the contrary, pronounces them "an eligible and safe reliance." Their value depends on the probability of the completion of a single track to lake Erie within four years from this time; a contingency involving "a responsibility which they (the late board) do not feel themselves called on to assume."

The above extracts will, however, sufficiently explain the tone of the two reports. They differ essentially, we might even say they have few points of resemblance, and we are bound to confess that the change is not for the better. For example, what is the use of declaring war against "the more northern route to the lakes," and exciting the hostility of the central counties from Albany to Buffalo, and of the counties on the eastern bank of the Hudson? We have never heard it hinted that the appeal of the late board to the public last spring, failed from any opposition created by the friends of "the more northern route to the lakes," and we doubt whether any such influence will be exerted against the present address, notwithstanding its—as we believe—unfair, and certainly unfortunate insinuations. It is less wounding to our self-love to ascribe our failures to the machinations of rivals, real or supposed, than to our own incapacity. The present board, that is the *acting* portion of the directors, have long controlled the management of the New York and Erie railroad, and we would venture to suggest the bare possibility that *some* part of their present difficulties may be owing to the circumstance that their past course has not been quite as satisfactory to the public, and especially to the *stockholders*, as it appears to have been to themselves. In our enlarged sheet we will endeavor to state

clearly and fairly the obstacles which the New York and Erie railroad has to surmount. We will also notice certain injurious impressions entertained by large portions of the community, which we shall be happy to aid in removing.

We take a different view of the work from either the present or the late board. We place its claims on higher ground than they do, and shall take an early opportunity of developing our views, which we shall endeavor to do in such a manner as to enable those opposed to us fully to understand our position, and, if in error, to point out where we are wrong. We have uniformly and untiringly advocated the cause of this great work, as our columns for the last ten years will abundantly show. We have even permitted our zeal to influence us so far as to pass by without animadversion proceedings which we did not approve of. This we shall do no more, convinced as we are that the cause of railways is forwarded as much by the exposure of abuses as by giving publicity to improvements. While keeping a watchful eye on the latter as usual, we shall at the same time try to steer clear of the censure conveyed in the motto of the Edinburgh Review. In justice to ourselves we may be permitted to observe that a monthly journal is scarcely a proper organ for such discussions, but with a weekly sheet we shall again and again refer to the New York and Erie railroad, and we hope not without effect.

The proof sheets having failed to reach the author there are numerous errors in the "explanation" of the Tables of Excavation and Embankment, but fortunately the tables themselves are correct. We regret this the more as we had taken great pains to follow the manuscript, which was unfortunately incorrect, and the proofs having failed to reach their destination and of course, not hearing of them, we supposed that all was right.

Page 162 line one from bottom, for $(D—d)_2 \frac{mL}{6}$, read $(D—d)^2 \frac{mL}{6}$.

Page 164 line six from top, for the areas $a\,i\,E$, read the areas $a\,l\,E$. The d at the end of this line and the h at the beginning of the next line ought to be together on the same line.

Page 165, if the latter part of table XXII is left out 200 on line four from top should be changed to 182. E at the end of line seventeen and E′ at beginning of line eighteen should be together. The same remark applies to A′ L′ at the end of line twenty-seven and E′ at beginning of line twenty-eight. Line thirty for $\frac{T\,P\,x^3}{3\,M\,M}$, read $\frac{T\,P\,x^3}{3\,M\,M'}$.

Page 166 line fourteen, for F, read (F).

" 169 line nineteen, for $2\,b^2\,y$, read $2\,b\,y^2$.

" 170 line twelve, for 109·529, read 109·259. Line fifteen, for 120·731, read 120·371.

Page 198 line twenty-eight, for $\frac{7+100}{7\times 33}$, read $\frac{7\times 100}{7+3}$.

Page 199 the working of example 7 should be as follows:

Depth in feet.	H + H′ in feet.	C. ys. from table xxii.	H — H′ in feet.	C. ys. from table xiv.
0·0				
2·0	22·0	1792	2·0	1
3·6	25·6	2427	1·6	0
8·9	32·5	3912	5·3	9
12·4	41·3	6317	3·5	4
14·0	46·4	7974	1·6	1
9·0	43·0	6848	5·0	8
6·0	35·0	4537	3·0	3
4·2	30·2	3378	1·8	1
2·1	26·3	2562	2·1	1
0·0	22·1	1809	2·1	1
		4)41,556		29
		10,389		
		29		
		10,418		

Now $\frac{B}{2m} = 10$, the correspondig number table xxii is 370,

$$\text{And } \frac{370 \times L (= 1000)}{100} = 3700$$

10418

6718

Hence $6718 \times m (= 2) = 13,436$ cubic yards is the total content of the excavation.

Page 200 line eleven, multiplied by ·0473, should be placed opposite to 3740, and the inverted commas opposite to 3740 should be omitted.

853
149
6

The same remark applies to the second method of working this example. All the examples are carried out in detail to show the whole operation and the multiplications being performed by the contracted method the figures of the multipliers are ranged in inverted order under the multiplicand.

The number 6046 at bottom of page 200 should be placed over the multiplier 3820 at the top of page 201 and the "c. yds." and inverted commas opposite to 3820 should be omitted.

1209
484
18

Page 201 line thirty-one, place $\frac{1}{12}(Y + y)$, etc. = ·2783, opposite to 3872 in the line above.

Page 202 line thirty, the figures 2214, should be 2214·2 and should also be moved one place to the left and so should the figures under it also. Line thirty-three, multiplied by $\frac{1}{12}(Y \times y)$, etc. = ·0197, should be opposite to 7910 in the line above.

Page 203 lines two and three, for $(A' - a)$, read $(A - a')$. Line thir

teen, place multiplied by etc. = ·0047, opposite 7400 in the line above. Line eighteen, place multiplied by etc. = 0197, opposite 7910 in the line above. Line thirty-one, for $(P - p')$, read $(P' - p')$.

Page 204 line one from bottom, omit "by formula ( )."

Page 205 line twenty-one, place $A \times \frac{L}{3} = \frac{1501}{3}$ etc. = 0175, opposite to 5710 in line above.

Page 207 line thirteen, for "on H," read or H.

TO CORRESPONDENTS.

We acknowledge the receipt of sundry papers on the late explosion of the locomotive Richmond, and shall endeavor to lay before our readers in our next a general review of the facts in this remarkable occurrence. The valuable papers of the United States engineers we have alluded to elsewhere. The report of the Madison and Indianapolis railroad is received and will be noticed in our next. An elaborate paper on the "Repeal of the duty on railroad iron," by Mr. Casey, will most likely appear in our January number. The views of the writer differ from ours, and we confess that they are more in accordance with the popular voice, especially in the mining region in Pennsylvania. A review of the objections to a railroad in Broadway, by Alba Kimball, in which the writer goes at length into the various advantages which would result, and the comparative ease with which the obstacles may be overcome. We shall gladly insert any information from "J. C." as to the performances of his iron steamer, and the merits of the new propeller, which is said to exceed Ericsson's in speed, and with a saving in fuel.

ITEMS.

The subscription to the new stock of the New York and Erie railroad goes on well. Nearly all the papers are out in favor of it, and the time is very favorable, as well on account of the abundance of capital as the early closing of the canal, which brings the merits of railways home to the community.

A temporary track has been laid through the Long Island tunnel, but the revetment walls of the approaches are not completed. Bitter complaints are made of the mode in which the company have conducted the work.

The rates of freight during the winter on the railways from Albany to Buffalo are fixed at 3, 4, and 5 cents, per ton per mile, besides what the companies pay the State, 1 and 2 cents per ton per mile, according to the nature of the freight. From New York to Albany, via. the Housatonic railroad, the rates are 7, 9, and 12 dollars per ton of 2000 lbs.

The use of the Drummond light on railways has been suggested to us as likely to be useful in many cases.

The "canallers" at Montreal are very troublesome, and occasionally shoot the citizens within a few miles of that city, with perfect impunity. These occurrences cause public works to be viewed with dread by those in

the vicinity, and are deeply to be regretted. But, after all, their conduct well matches that of the board of works, and never was the old adage, "like master like man," more thoroughly verified.

Our Canadian neighbors are waking up on the subject of railroads, and we shall gladly do all in our power to lead them to the construction of works destined to serve the country, and not to fill the pockets of political adventurers.

We beg to acknowledge the receipt of the first and second numbers of "Papers on Practical Engineering," from Col. Totten, chief engineer of the United States. The second of these has appeared in the *Journal*, and the first we shall have occasion to refer to hereafter. The style in which these papers are published leaves nothing to be desired, and we trust they will follow each other more rapidly than they have hitherto done. We would suggest that simple and clear statements of work done would be more useful than ambitious papers, aiming to become regular treatises, a fault into which young engineers are apt to fall, and to whom we would point out No. 2, by Col. Thayer, as a model.

TO DIRECTORS, ENGINEERS AND SUPERINTENDENTS OF RAILROADS AND CANALS.

It is our intention to give in the *enlarged Journal* a table of American railways in the manner of the English railway journals. We therefore earnestly request from our readers a statement of the length, cost, gross income, net income, dividends and value of stock and such information as may be necessary to give a correct view of the present state of the several railways and canals with which they may be acquainted. For example, it is important to know whether the road or canal is finished, if the profits go to pay interest on bonds, to extend the work, to renew the track, etc. Without these explanations many works would be placed in a very wrong light and would appear to be worthless, when, in fact, they were just emerging from their difficulties and about taking their permanent stand among the roads paying regular dividends. This information is demanded alike for themselves as well as for the cause of railways generally. Many gentlemen may also be acquainted with the particulars of roads little known, and may be pleased to give the details of such along with those of the roads or canals with which they are more immediately connected.

But, in *all* cases, we hope to receive the length, cost to this time and gross income of 1843 and 1844 to November or to the end of the year, approximately the amount as nearly as practicable. Regular returns of weekly receipts, as now published by many companies, are very desirable and aid powerfully in drawing the attention of the public to the large amounts received by these works even in the most unpromising situations. It is our intention to publish such a table and we hope to include many roads who now make only annual reports.